CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

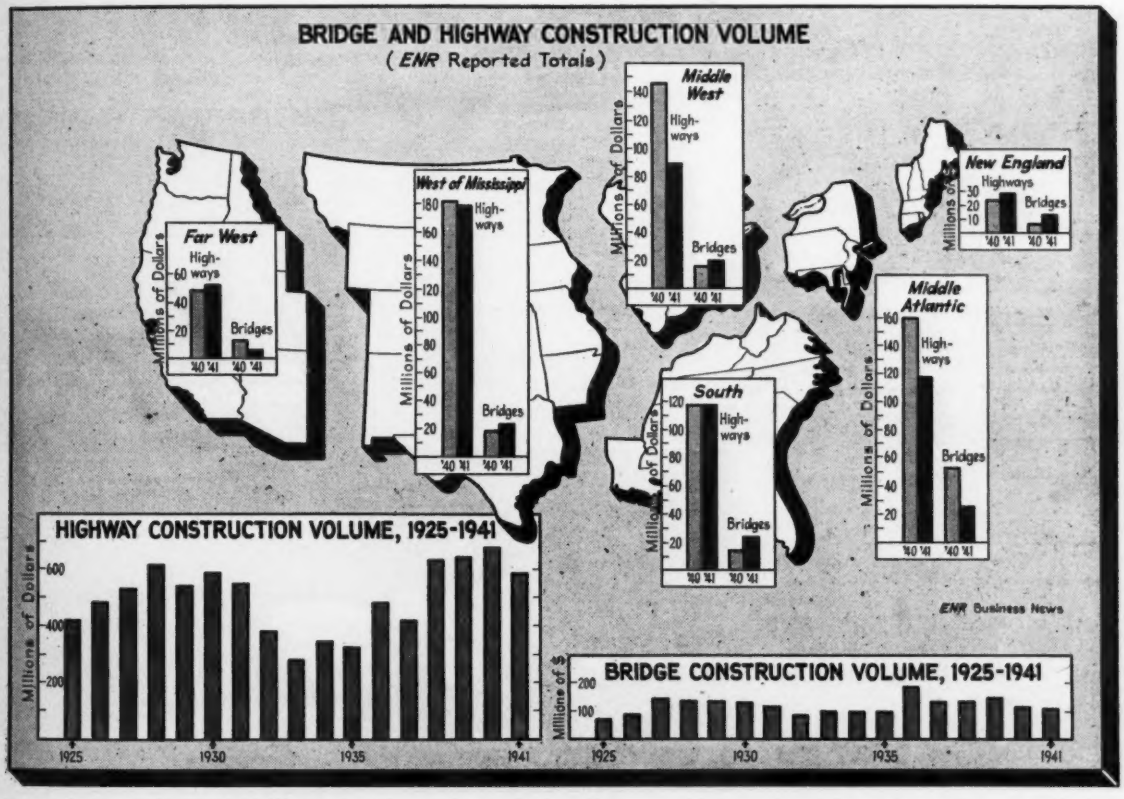
ENR Highway and Bridge Volume Lower

THE NATION'S HIGHWAY construction volume for 1941 reported by *Engineering News-Record* for state, county, town and federal roads totaled $582,847,000, 14 percent below the all-time peak of $678,172,000 reached in 1940. The sharp drop in local road work was responsible for the decrease as state work increased 6 percent. Bridge construction for the past year, $111,628,000, declined 7 percent from the preceding year's volume.

Two of the six sections of the country reported increased highway construction volume as compared with 1940. New England lettings were 22 percent higher, and Far West total gained 8 percent. Two other areas almost matched their 1940 volumes, West of Mississippi, 1 percent under, and the South down just 0.2 percent. Middle Atlantic and Middle West dropped 27 and 40 percent, respectively, from the preceding year's levels.

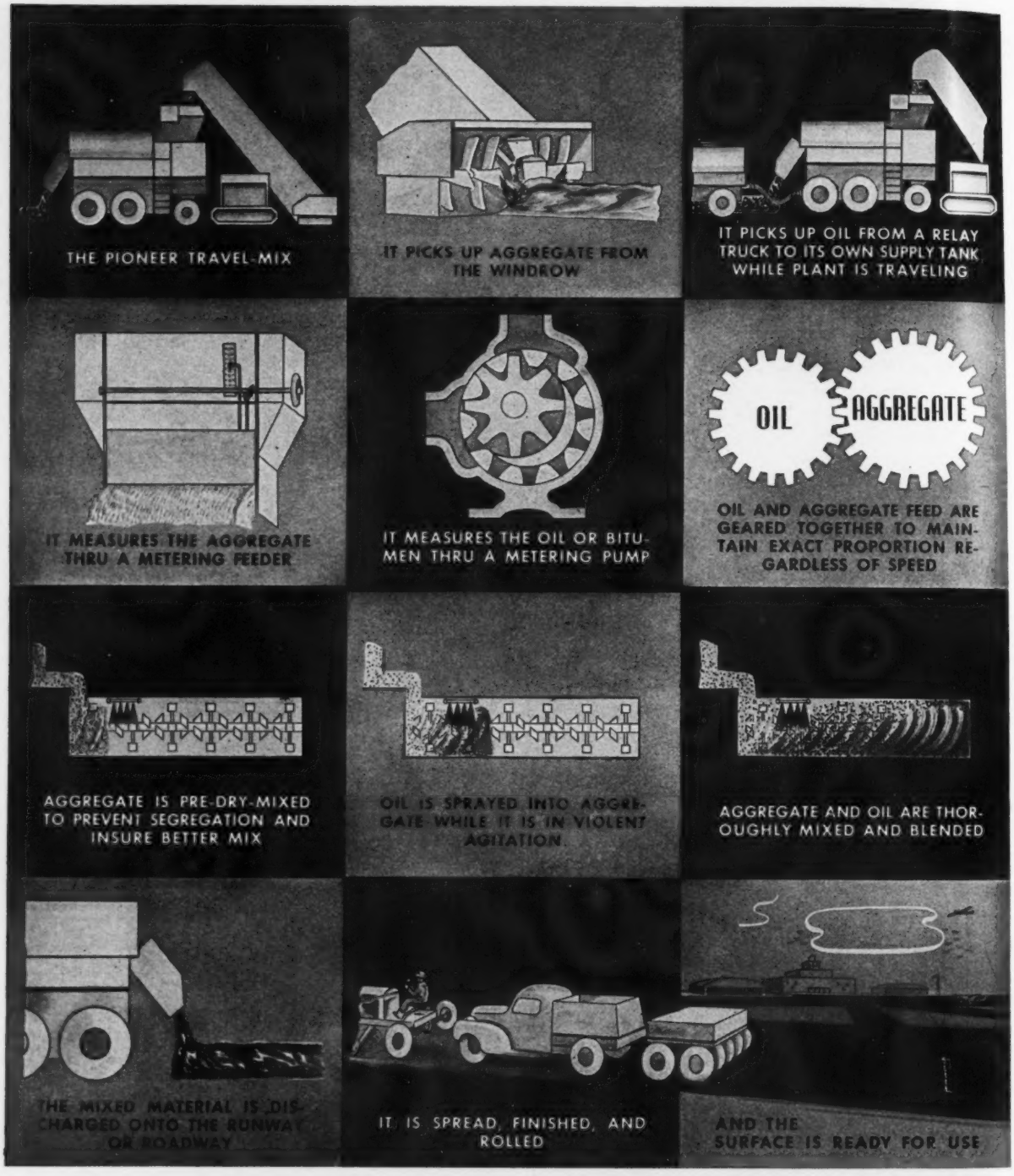
Four geographical sections topped their 1941 bridge construction marks, but sharp declines in the Middle Atlantic and Far West offset these increases. New England bridge volume climbed 79 percent; South, 78 percent; Middle West, 18½ percent; and West of Mississippi, 25 percent. Middle Atlantic and Far West were 51 and 46 percent lower, in that order.

Despite better than average totals for both highways and bridges, their respective volumes represent only 9.9. and 1.9 percent of the 1941 heavy engineering construction work as compared with 17 percent for highways and 3 percent for bridges in 1940. Greater emphasis on defense buildings, airports and airbases, and shipbuilding facilities, plus the failure to appropriate funds for defense roads until late in the year, were the prime factors that resulted in the lower highway and bridge shares of the 1941 construction total.



ENGINEERING NEWS-RECORD. Published every Thursday. Vol. 128, No. 7. Price 25c per copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 West 42nd Street, New York, N. Y. Subscription, domestic, Mexico, Central and South American countries $5.00 for one year, $8.00 for two years, $10.00 for three years. Canada $5.50 for one year, $9.00 for two years, $11.00 for three years. Great Britain and British possessions 54 shillings for one year, 108 shillings for three years. All other countries $9.00 for one year, $18.00 for three years. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C. Copyright 1942 by McGraw-Hill Publishing Company, Inc., James H. McGraw, Founder and Honorary Chairman; James H. McGraw, Jr., President; Howard Ehrlich, Executive Vice President; Mason Britton, Vice Chairman; B. R. Putnam, Treasurer; D. C. McGraw, Secretary; J. E. Blackburn, Jr., Circulation Manager. Publication office: 99-129 North Broadway, Albany, N. Y. Editorial and Executive Offices: 330 West 42nd St., New York. Branch offices: 520 N. Michigan Ave., Chicago; 68 Post St., San Francisco; Aldwych House, Aldwych, London, W.C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

SURFACE AN *AIRPORT* QUICKER
with a PIONEER TRAVEL-MIX PLANT


THE PIONEER TRAVEL-MIX
IT PICKS UP AGGREGATE FROM THE WINDROW
IT PICKS UP OIL FROM A RELAY TRUCK TO ITS OWN SUPPLY TANK WHILE PLANT IS TRAVELING
IT MEASURES THE AGGREGATE THRU A METERING FEEDER
IT MEASURES THE OIL OR BITUMEN THRU A METERING PUMP
OIL
AGGREGATE
OIL AND AGGREGATE FEED ARE GEARED TOGETHER TO MAINTAIN EXACT PROPORTION REGARDLESS OF SPEED
AGGREGATE IS PRE-DRY-MIXED TO PREVENT SEGREGATION AND INSURE BETTER MIX
OIL IS SPRAYED INTO AGGREGATE WHILE IT IS IN VIOLENT AGITATION
AGGREGATE AND OIL ARE THOROUGHLY MIXED AND BLENDED
THE MIXED MATERIAL IS DISCHARGED ONTO THE RUNWAY OR ROADWAY
IT IS SPREAD, FINISHED, AND ROLLED
AND THE SURFACE IS READY FOR USE

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McGRAW-HILL PUBLISHING COMPANY, INC.

Publication Office: 99-129 North Broadway, Albany, N. Y. • Editorial and Executive Offices: 330 West 42nd Street, New York

JOHN ABBINK, *Publisher*

WALDO G. BOWMAN, *Editor* ALBERT E. PAXTON, *Manager*

Vol. 128 FEBRUARY 12, 1942 No. 7

THIS WEEK

• Trends in current thinking in major fields of highway activity are discussed in this *Annual Highway Number*. Major subjects covered are: concrete and asphalt paving, soil stabilization for highway base courses and embankments, and the design of divided highways. Supplementing these articles are two on highway bridges, one on timber bridge construction, now an important subject due to the shortage of steel, and one on widening highway bridges, also an important subject in the present emergency. The latest statistics of highway work done during 1941 and estimates of 1942 work have been included. This information is given by states and then is summarized in tabular and chart form. Given separately is the record of work on access roads and the defense highway network.

THINGS TO COME

• Without precedent as a guide, cylindrical steel columns, 95 ft. high, placed 110 ft. apart, were recently installed at a shipyard without the use of braces or guys. The columns support overhead crane rails 630 ft. long and 95 ft. apart, which were designed to carry a moving load of 165,000 lbs. Erection operations and design formula will be described in the Feb. 26, issue.

• How the capacity of existing trickling filters at sewage disposal works can be doubled by a simple change in operating methods will be revealed in an article describing recent experiences in England to be included in the Feb. 26, issue.

• Two bobtail swing spans are being built over the Miraflores locks of the Panama Canal, providing the first rail and highway connections between the continents of North and South America. This major defense project will be reviewed in an early issue.

• A method of accurately determining the moisture content of soil samples in less than 10 minutes, where granular materials are involved, has been developed and is being used in the field and in the laboratory at Mud Mountain Dam. A forthcoming article will describe this unusual and practical method.

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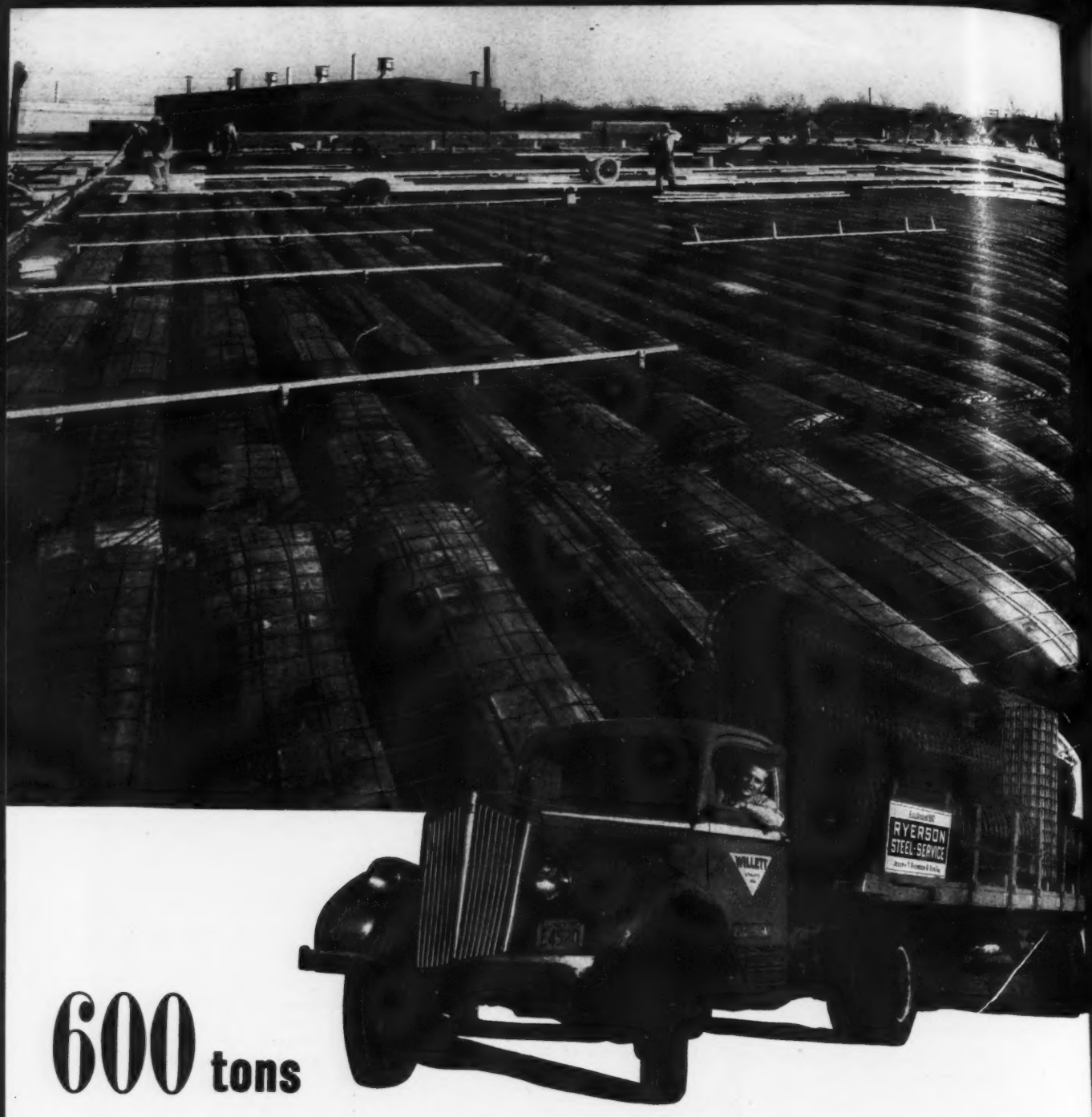
Number of copies of this issue printed: 36,820



600 tons of Ryerson Reinforcing used in this new Plant

Like thousands of other contractors, Dahl & Stedman—builders of this new Chicago plant—depend on Ryerson for prompt "on location" delivery of wire mesh, reinforcing steel and accessories.

It will also pay you to check with Ryerson whenever you need reinforcing bars, wire mesh, accessories, etc., for defense purposes. Bars are accurately cut, bent and tagged according to blue prints and specifications, and deliveries are always coordinated with the progress of the job.

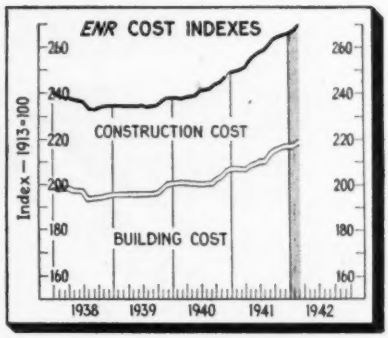
Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

MONTHLY CONSTRUCTION BUSINESS SUMMARY

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	January 1941 (5 wk.)	January 1942 (5 wk.)	% Change	December-January 1941 (4 wk.)	December-January 1942 (5 wk.)	% Change†
Total Construction	$584,549	$628,780	+7.5	$269,689	$628,780	+86.5
Private Construction	174,679	51,121	−71.0	47,952	51,121	−15.0
Public Construction	409,870	577,659	+41.0	221,737	577,659	+108.0
Federal	274,859	497,100	+81.0	167,650	497,100	+137.0
Total New Productive Capital	$93,988	$559,914	+496.0	$1,612,832	$559,914	−72.0
Private Investment	80,325	98,614	+23.0	45,582	98,614	+73.0
Federal (non-federal work)	13,663	11,300	−17.0	4,000	11,300	+126.0
Federal (federal work)	.....	450,000	.....	1,563,250	450,000	−77.0
FHA Mortgages Selected for Appraisal (Title II)	$85,993	$54,670*	−36.0	$64,230	$54,670*	−15.0

†*Adjusted for difference in number of weeks.* **Preliminary.*



CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	February 1941	February 1942	% Change	Changes January to February 1941 Jan.	1941 Feb.	1941 %	1942 Jan.	1942 Feb.	1942 %
E N R Construction Cost Index, 1913=100‡	250.50	269.41	+7.6	249.69	250.50	+0.3	267.63	269.41	+0.7
E N R Building Cost Index, 1913=100‡	208.42	218.44	+4.8	207.94	208.42	+0.2	217.12	218.44	+0.6

‡ *Does not reflect increased costs due to more overtime, lower labor efficiency, delivery delays, etc.*

ENR 20-CITIES' AVERAGE

Common Labor	$0.713	$0.780	+9.4	$0.711	$0.713	+0.3	$0.776	$0.780	+0.5
Skilled Labor (Av. 3 trades)	1.470	1.536	+4.5	1.469	1.470	+0.1	1.531	1.536	+0.3
Bricklayers	1.568	1.638	+4.5	1.568	1.568	0	1.626	1.638	+0.7
Structural Ironworkers	1.535	1.599	+4.2	1.535	1.535	0	1.599	1.599	0
Carpenters	1.307	1.370	+4.8	1.305	1.307	+0.2	1.370	1.370	0
Cement, per bbl	$2.51	$2.60	+3.6	$2.53	$2.51	−0.8	$2.60	$2.60	0
Reinforcing steel, per cwt	2.53	2.61	+3.2	2.53	2.53	0	2.61	2.61	0
Struct. steel shapes, base	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.17	1.21	+3.4	1.17	1.17	0	1.20	1.21	+0.8
Lumber, 2x4 Fir, per M ft.	40.68	47.57	+16.9	40.34	40.68	+0.8	46.74	47.57	+1.8
Lumber, 2x4 Pine, per M ft.	38.49	41.74	+8.4	38.07	38.49	+1.1	40.76	41.74	+2.4
Brick, common, per M	14.45	15.28	+5.7	14.44	14.45	+0.1	15.21	15.28	+0.5
Ready-mixed concrete, c.y.	6.93	7.20	+3.9	6.96	6.93	−0.4	7.17	7.20	+0.4
Struct. clay tile, 3x12x12	74.14	75.83	+2.3	74.14	74.14	0	75.65	75.83	+0.2
Paving Asphalt, cars, ton	14.24	15.28	+7.3	14.24	14.24	0	15.21	15.28	+0.5

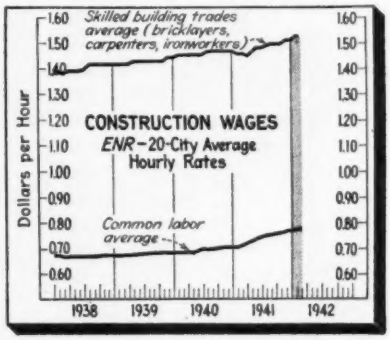
ENR INDEX NUMBERS

Base=100	Construction Cost 1913	Construction Cost 1926	Building Cost 1913	Building Cost 1926	Volume '13	Volume '26
Feb., 1942	269.41	129.51	218.44	118.08	...	...
Jan., 1942	267.63	128.65	217.12	117.37	503	221
Dec., 1941	266.16	127.94	216.37	116.96	217	95
Nov., 1941	266.13	127.93	216.54	117.05	282	124
Oct., 1941	264.46	127.13	215.92	116.72	263	115
Sept., 1941	263.12	126.48	214.58	116.00	419	184
Aug., 1941	260.41	125.18	212.45	114.84	434	190
July, 1941	258.18	124.11	210.22	113.64	635	278
June, 1941	256.79	123.44	209.41	113.20	492	216
May, 1941	255.55	122.84	209.24	113.11	275	121
April, 1941	252.40	121.33	208.60	112.76	322	141
Mar., 1941	250.71	120.52	207.88	112.37	386	169
Feb., 1941	250.50	120.42	208.42	112.67	374	164
Jan., 1941	249.69	120.03	207.94	112.46	402	176
1941 (Av.)	257.84	123.95	211.46	114.32	375	164
1940 (Av.)	241.96	116.31	202.81	109.64	269	118
1939 (Av.)	235.51	113.21	197.44	106.73	211	92
1938 (Av.)	235.86	113.34	196.83	106.40	197	86

MATERIAL SHIPMENTS . . . BUILDING PERMITS

	January 1941	January 1942	% Change	Dec. 1941	% Change Dec.-Jan.
Lumber (% 1935-'39 week seas. av.) N.L.M.A.	148.6	136.0	−8.5	121.3	+12.1
Steel (% operating capacity) A.I.S.I.	95.9	97.1	+1.3	96.2	+0.9

	December 1940	December 1941	% Change	Twelve Months 1940	Twelve Months 1941	% Change
Fabricated Structural Steel, tons, A.I.S.C.	155,526	176,126	+13.3	1,515,543	2,251,089	+48.5
Cement, thous. bbl., U. S. B. of M.	8,192	11,511	+41.0	130,315	167,508	+28.5
Building Permits, Dun & Bradstreet (,000 omitted)	$113,552	$93,848	−17.4	$1,362,666	$1,463,265	+7.4



COST OF LIVING INDEXES

	December 1940	December 1941	% Change	Nov. 1941	% Change Nov.-Dec.
Cost of Living Index, N.I.C.B.	85.9	93.4	+8.7	92.9	+0.5
Rent (Housing) Index, N.I.C.B.	87.5	89.9	2.7	89.5	+0.4

ENGINEERING CONSTRUCTION CONTRACTS——ENGINEERING NEWS-RECORD——JANUARY, 1942

Engineering News-Record *reports projects of the following minimum costs;—waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000 *industrial buildings,* $40,000; *other buildings* $150,000

Five Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States January 1942	United States January 1941	Canada
Public Works									
Waterworks	837	951	1,911	1,071	1,139	872	**6,781**	7,314	191
Sewerage	1,253	3,216	418	744	688	1,315	**7,634**	14,062	112
Bridges, public	720	2,928	1,008	2,307	667	1,039	**8,669**	18,423	30
Earthwork and waterways	243	3,527	99,708	1,077	3,708	5,366	**113,629**	5,462	.....
Streets and roads	1,105	8,394	6,794	6,955	7,341	2,615	**33,204**	55,720	567
Buildings, public	6,003	89,557	70,202	70,896	44,034	30,605	**311,297**	251,812	2,085
Unclassified, public	9,070	13,817	43,505	655	9,707	19,691	**96,445**	57,077	2,701
Total public	**19,231**	**122,390**	**223,546**	**83,705**	**67,284**	**61,503**	**577,659**	**409,870**	**5,686**
Federal government (included in above classifications)	14,872	102,468	213,063	62,836	56,292	47,569	**497,100**	274,859	.....
Private									
Bridges, private	.....	.....	32	.....	.....	60	**92**	629	.....
Buildings, industrial	2,323	4,588	1,000	3,405	6,769	1,615	**19,700**	85,081	1,460
Buildings, commercial	2,695	12,963	2,922	1,312	3,165	3,285	**26,342**	66,605	310
Unclassified, private	25	816	2,008	321	1,340	477	**4,987**	22,364	400
Total private	**5,043**	**18,367**	**5,962**	**5,038**	**11,274**	**5,437**	**51,121**	**174,679**	**2,170**
Total Engineering Construction:									
January, 1942 — (5 weeks)	**24,274**	**140,757**	**229,508**	**88,743**	**78,558**	**66,940**	**628,780**	.....	**7,856**
December, 1941 — (4 weeks)	15,181	73,813	47,689	40,115	50,515	42,376	269,689	.....	17,596
January, 1941 — (5 weeks)	32,337	129,933	135,000	125,108	78,901	83,270	.....	584,549	7,554

TIME FOR COMPLETION CUT IN HALF! NUMBER OF FORMS USED COST OF FORM LUMBER

● Atlas High-Early cement speeded completion of this processing building and warehouse, Barrington, Ill. Architects, Holabird and Root; Contractors, Dahl-Stedman Company, both of Chicago.

Atlas High-Early cement used on three-story warehouse helped save time, labor and cost!

PLANS called for three-story concrete frame warehouse with concrete floor slabs. Dahl-Stedman Company, the contractors, specified Atlas High-Early cement and *saved in these ways:*

THEY SAVED TIME. The superintendent states that Atlas High-Early cement cut the time for completion of this project approximately 50%.

THEY SAVED FORMS. By using Atlas High-Early cement, they were able to strip forms in from three to four days. With regular portland cement it would have been necessary to wait about seven or eight days before forms could be stripped. This made possible a 50% saving in forms and form lumber.

Atlas High-Early cement can save time and dollars for you . . . Atlas High-Early cement gains working strength rapidly—often cuts time for protection and curing as much as 60% to 70%. In many cases it permits early stripping of forms for re-use and results in a substantial saving in form costs. Atlas High-Early cement also more than pays for its slight extra cost on many jobs. It will pay you to consider it for *your* next job. Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

OFFICES: *New York, Chicago, Philadelphia, Boston, Albany, Pittsburgh, Cleveland, Minneapolis, Duluth, Kansas City, St. Louis, Des Moines, Birmingham, Waco.*

ENR-2-12-42

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • FEBRUARY 12, 1942 • VOLUME 128 • NUMBER 7

War damage clause inserted in all engineer contracts

Contractor absolved of any responsibility for damage to government property, and damage to contractor's plant is studied by corps; no decision on existing contracts.

The Corps of Engineers is now inserting into all its new construction contracts a clause recognizing that the contractor shall not be held liable for damage to the project resulting from enemy action. This clause (*ENR*, Feb. 5, p. 14) stipulates that any damage may be repaired by the contractor under a change order.

It is not yet certain what will be done about existing contracts. No war clause has yet been blanketed into these contracts, but it is recognized that in some situations, at least, this may be necessary.

Even more uncertain is the handling of damage to the contractor's own equipment and injuries to his employees. It is generally recognized in the War Department that contractors must be compensated for such losses, but the exact method is still to be worked out. Any final solution will probably be held up until the RFC works out its scheme for a general war damage insurance system. A bill now before Congress provides for setting up such a plan. Details are very vague, but present intention is to grant automatic property insurance up to $15,000, with additional insurance available, perhaps through fire insurance companies, upon payment of a premium.

If this plan goes through it will probably be relied on to protect contractors against property loss. It will still leave, however, the question of compensation for personal injury, and this will probably be covered by a contract clause.

Meanwhile, Congress has authorized the Navy's Bureau of Yards and Docks to use any of its public works appropriations to compensate contractors and their employees for losses arising as the "direct result" of enemy action.

The Seattle district office of the U. S. Engineers last week announced it had inserted a war damage clause in its specifications for airport work, which read as follows:

"It is expressly understood and agreed that the contractor shall not be liable for damage to or destruction of the work or any part of the work covered by this contract resulting from enemy operations. In the event the work covered by this contract is damaged due to enemy operations, the contractor shall, if so ordered by the contracting officer, repair such damage under a change order stipulating the additional sum to be added to the contract price and the additional time for performance. In the event the work covered by this contract is destroyed or damaged due to enemy operations and the government decides not to replace or repair such work, the contractor shall be paid all costs reasonably incurred in connection with the prosecution of the work."

• • •

Ask funds to house federal employees

An expected increase over pre-war levels in Washington's population of some half a million by the middle of summer has brought a request from Charles F. Palmer, Defense Housing Coordinator, for $50,000,000 to finance immediate construction of 10,000 homes for federal workers. The sum also would provide for the building of schools, water works, sewers, refuse disposal system, hospitals, streets and recreation facilities.

The money would be provided by amendment of the Lanham Act, which authorizes appropriations for housing industrial and war workers, but does not provide for homes for federal workers in the District. Hearings are now underway.

The new program calls for construction of homes for workers in the $2,000 income bracket. It is estimated that at least $10,000,000 will be needed for constructing needed utilities and community facilities, leaving $40,000,000 for erection of about 10,000 dwelling units.

More than 71,000 new Federal employes came to Washington between April, 1940 and December 1, 1941. This represents a population increase of more than 210,000 not including the several thousand officers and enlisted men of the army and navy. Meanwhile, only some 33,000 housing units, half apartments and half single-family dwelling units, have been built during this period.

Now under construction in the Washington area are about 5,250 housing units financed from war housing appropriations. These are for Army and Navy employees and industrial workers. Moreover the RFC's Defense Homes Corp. is planning to build about 4,500 houses for federal workers, but these are not yet under construction.

The President has allocated $19,800,000 to the Alley Dwelling Authority out of the $300,000,000 fund for demountable housing to permit construction of 4,500 houses in the district. This money was not included under the Lanham act restrictions, which prevent use of other housing funds in the district.

New supervising architect

George Howe, of Philadelphia, has been appointed Supervising Architect of the Public Buildings Administration, Federal Works Agency, succeeding Louis A. Simon of Baltimore, who retired recently. An architect for more than 25 years, Mr. Howe has been associated with the office of Supervising Architect as consultant since 1939.

WASHINGTON HIGHLIGHTS

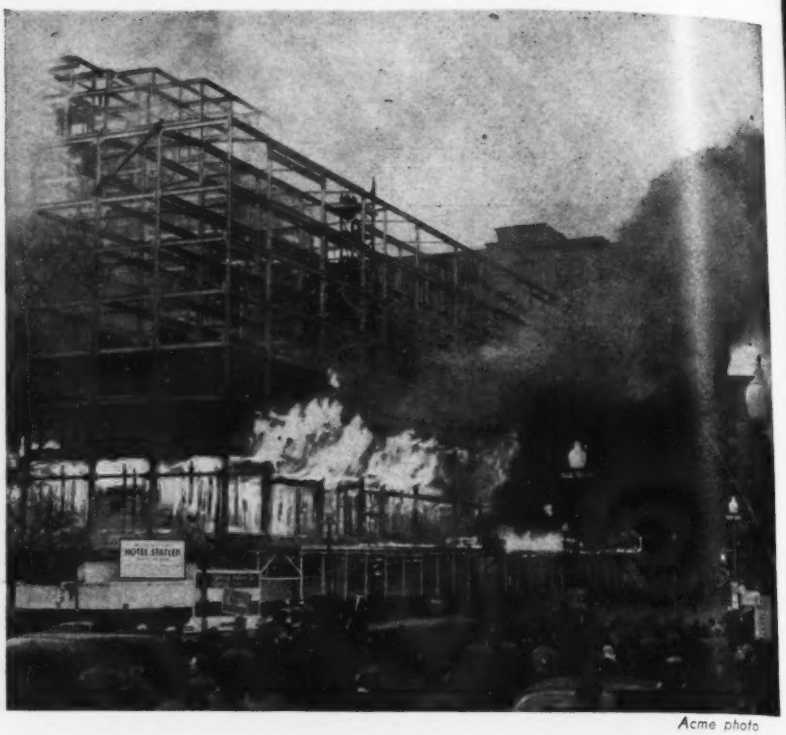
THE BUREAU OF RECLAMATION has asked Congress to revise the 1937 act which was passed to prevent speculation in lands to be irrigated by the Grand Coulee project. That act provided for appraisals (which are now complete) of the unirrigated value of the project lands and provided penalties for sale of the land at more than the appraised value. The proposed revision, instead, would in effect forbid sale of the land at more than the dry price and make it impossible for the seller to collect any excess price. The bureau would be directed to divide the project area into homesteads of a size, up to 160 acres, suitable for the support of one family. Persons owning more land than is contained in one such homestead would be unable to get water for the extra land and would be required either to sell the extra land at the dry price or give the government a power of attorney to sell it for them. Other provisions would permit the government to build townsites on the project land and to make improvements to homesteads, to be paid for by homesteaders at 3 percent over forty years. Because of the war, the irrigation phases of the Grand Coulee project have been indefinitely deferred.

THE NEW SAULT STE. MARIE lock, authorized by the Senate last week in a separate bill for immediate construction is being held up in the House. The rivers and harbors committee has included it in the omnibus river and harbor authorization bill, which will not be reported for some weeks.

CIVILIANS who worked on construction of the Panama Canal would be granted annuities under a bill which the Senate passed last week and sent to the House.

STEEL PLATE users are being pressed by WPB to make the maximum possible use of plate less than ¾ in. thick and 72 in. wide. About a third of the potential plate making capacity of the steel industry arises from the conversion of strip mills, most of which can only make plate in the thinner and narrower sizes. The heaviest defense demand is for the thick wide plate which can only be made by sheared plate mills representing a little over a quarter of the plate capacity, and it is therefore desired to conserve these sizes as much as possible.

PRICE SCHEDULE NO. 94 will freeze Western pine lumber prices at about the levels of early last October, $2 to $5 per thousand below current levels.



Acme photo

Spectacular formwork fire does only slight damage

Preliminary inspection indicates that the new Statler hotel under construction in Washington, D. C., came relatively unscathed through a formwork fire last Sunday.

A steel frame structure with reinforced concrete floors, steelwork was completely erected and the first and second floors poured and stripped when the fire broke out. Forms for the next floor above (called the fourth floor) were in place, and concrete pouring was about 75 percent complete on Sunday. The most recently placed concrete in this floor was 48 hr. old and the oldest had been placed eight days previously. Erection of forms and placement of reinforcing steel for the fifth floor had started.

The fire is believed to have started between the second and fourth floors, and fed on the fourth floor formwork and bracing. Although first reports said the blaze started from salamanders being used to warm the concrete, investigation indicated that all salamanders had been extinguished the previous night.

None of the recently-poured concrete collapsed and none is obviously sagging, but measurements are now in progress. Until more debris is cleared, it will not be known if there was any spalling of this or the second-floor concrete. A dozen light steel girders are seriously warped and must be replaced, but pending more detailed study, it appears that none of the columns is injured. Some of the fifth floor formwork collapsed, and the lower part of the steel erection lift was warped in places. The fact that the building was not closed in, and a high wind was blowing, apparently prevented any serious concentration of heat that would have resulted in more damage.

Ontario to complete Trans-Canada Highway

Completion of the last link in the Trans-Canada Highway is to be carried forward despite war conditions, according to an announcement made recently by Premier Hepburn of Ontario. Work on the 153-mile uncompleted portion between Hearst and Geraldton in northern Ontario was begun last year but was slowed up by Canada's war effort. It is to be continued as a war measure, there being no highway in Canada connecting the eastern provinces with the prairie provinces.

Dorr Company speeds Pearl Harbor sewage job

The Dorr Company has received an order, carrying an A-1-a priority rating for sewage treatment equipment for a disposal plant to serve the U. S. Naval Hospital at Pearl Harbor, Hawaii. It is to be of the biofiltration type, with a capacity for 2,000 population, and will include a combination primary clarifier and sludge digestion tank. One week after receipt for the order 22 new drawings for the job had been completed and manufacturing orders had been issued to fabricating shops.

Munitions plant expansion to double U.S. arms production capacity

President asks $3,931,000,000 for addition of new manufacturing capacity as part of bill covering Army expansion

New presidential requests for funds this week demonstrated that a munitions plant expansion program even bigger than last year's schedule is lined up for 1942.

Since the beginning of the year, new plant expansion funds totalling more than seven billions have been put on the books. As predicted on these pages (*ENR*, Dec. 25, p. 1), the United States is going to more than double its munitions plant capacity. The pre-Pearl Harbor armament factory program totaled just over six billion dollars—five-sixths of it financed with public funds.

This week the President asked for $3,931,000,000 for addition of new manufacturing capacity. To this must be added the $933,000,000 for airplane plants included in last month's Air Force expansion bill and a substantial part of the $2,500,000,000 increase in RFC borrowing capacity now pending before Congress.

The President's latest request is included in the $23,000,000,000 supplemental estimate to cover part of the cost of expanding the army. Troop housing costs are not included in this estimate, but probably will be covered in another War Department appropriation due soon.

Although expenditure of this money will unquestionably involve a huge construction program, it is to be expected that a larger proportion than formerly will go for machinery, rather than buildings. Elimination of much civilian manufacture will make a lot of floor space available.

The twenty-seven billion dollar naval appropriation bill for fiscal 1943—largest single appropriation which has ever passed any legislature—contains just over a billion dollars for public works of the Bureau of Yards and Docks. For the current fiscal year just under a billion has been provided.

The bill appropriates $528,705,000 in cash and $500,000,000 in contract authorizations. Unlike previous appropriations for naval public works, this money is provided in a lump sum with no specification as to the projects on which it is to be spent. It is stated, however, that a large part of the contract authorizations will be used for construction of huge supply depots on the coasts of the continental U.S.

Photo by Press Association, Inc.

Army cars use uncompleted Panama highway

Army units in the Canal Zone are already using the uncompleted grade of the new highway connecting the ends of the Panama Canal. Cut through tropical jungle from near Madden Dam for 24½ miles to the Atlantic end of the canal, the new highway will provide an all-weather road from Balboa to Colon. The only land connection now is the Panama Railroad. (ENR July 17, 1941, p. 96).

A concrete highway was built from Panama City and Balboa to Madden Dam about ten years ago to facilitate construction of the dam. It is about 25 miles long. The new road, largely outside the Canal Zone on a right-of-way provided by the Republic of Panama, also is to be of concrete, two 10-ft. lanes separated by a 4-ft. median zone of oil-treated gravel. Grading of this road is well advanced and paving has started. It is expected that work will be completed before the rainy season begins in May. Construction is by force account under direction of the Public Roads Administration.

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Roadbuilders survey powered equipment

A survey of the amount of powered roadbuilding equipment in the hands of highway contractors is being made by the American Road Builders Association. Started about two weeks ago, the survey is still underway. The figures are expected to throw some light on the problem, now being studied by WPB, of how much material needs to be allocated this year to manufacture of construction equipment.

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War factory work yields duPont under 1 percent

Ordnance plant construction work undertaken by E. I. duPont de Nemours & Co. will yield a return of about 1 percent, according to the 140th annual report released this week for the company.

W. S. Carpenter Jr., president, asserted that the company is making an "effective and substantial" contribution to the armament program, primarily through erection and operation of the government-owned ordnance plants, but also in its own factories. Mr. Carpenter said that the ordnance plants will require "several hundred million dollars" of government funds for their construction and probably an even greater additional outlay for their operation, depending on the duration of the war.

He explained that contracts were taken on a cost-plus-fixed-fee basis because their urgency would not permit detailed preparation of cost estimates. On the construction work, he said, duPont expects a return of about 1 percent, while the plant operations will yield an average of about 5 percent of the cost involved, both computations made before federal taxes are deducted.

Civilian emergency roads get special markers

Designating clearly secondary roads available to civilian motorists should main arteries be pre-empted by military authorities, New York, New Jersey and Connecticut are cooperating in a program to erect distinctive markers, according to Billings Wilson, chairman of the Metropolitan Defense Transport Committee, New York.

The alternate road markers will serve a dual purpose, Mr. Wilson said, in that they will provide clearly marked bypasses for motorists wishing to avoid traffic jams.

The new markers, standard black and white wooden signs, will carry the state initials, the route number, and the word "civil". Route numbers are all in the 500's, ranging from 501 to 594. Whenever possible, the new numbers will be related to the existing highways which they parallel—for example, Civil Route 501 will parallel U. S. Route 1; Civil Route 532 is an extension of N. Y. Route 32 into New Jersey.

Erection of the signs in Connecticut and in New York State above the New York City line is nearly completed. New York City markers probably will be put up within thirty days and work on the New Jersey signs is in progress. The new route numbers will be shown on all the 1942 New York metropolitan area road maps.

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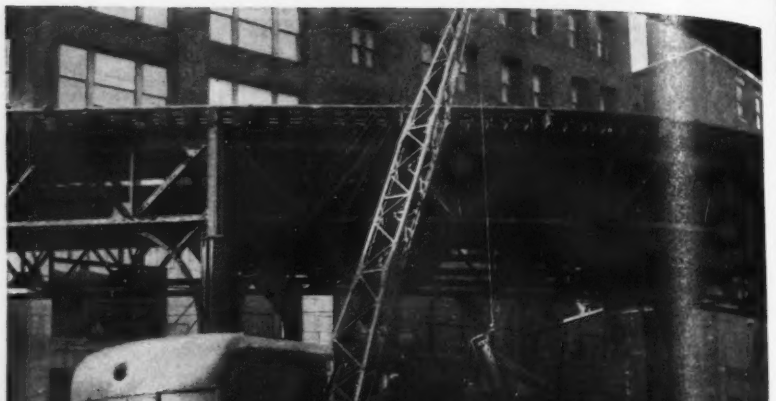
Canada strengthens its building license control

C. D. Howe, Canadian minister of munitions, announced at Ottawa the issuance of a new order-in-council superseding existing restrictions and drastically tightening Canadian government control over all construction activities in the Dominion.

The new order makes it mandatory for any person constructing, remodeling or making repairs to a building, or who contemplates installing equipment, to obtain a license from Construction Controller C. Blake Jackson, if the work is to have an overall cost exceeding $5,000.

Sole exemptions to the order are federal government projects and work financed entirely by the federal government. Controller Jackson is empowered to reduce the $5,000 limit still further if the present shortage of steel and other materials or the shortage of manpower makes it necessary.

Cutting out all previous exemptions, which included works for logging, mining, fishing, etc., and much private construction, and reducing the previous value limit from $10,000, the new order in effect puts control of practically all construction activity in Canada under the direction of the federal government.



Demolition starts on Boston elevated railway

Demolition work by the Boston Elevated Railway on 2 miles of its Atlantic Avenue line began Feb. 3 after the Massachusetts State Supreme court had ordered the company to dismantle the structure at its own expense. The line has been shut down since Oct. 1, 1938 due to excessive cost of operation in relation to revenue.

The railway itself decided to dismantle a portion of the line for the recoverable material in it, but the greater part will be removed by contract for which bids will close on Feb. 18. It is estimated that over 9,000 tons of scrap steel and iron and 356,906 lbs. of copper will be recovered. Most of the steel and iron will be utilized for war purposes.

Schedule New York truck terminal hearing

The Port of New York Authority has set Feb. 24 as the date for a public hearing on a proposal for immediate construction of a $2,000,000 motor truck terminal to speed deliveries by long distance motor carriers. More than 200 scattered terminals now serve the city.

The proposed terminal would be a four-story structure covering about 75,000 ft. of ground area, providing facilities for freight handling and offices.

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Pennsylvania abandons much new highway work

Pennsylvania's 1942 new work program for the state highway department, originally estimated at $40,000,000, has been virtually abandoned because of the war and only new construction vital to military movements and defense work will be given clearance, the state highway department announced recently at Harrisburg.

The approximately $18,000,000 allocated for maintenance work will be expended as scheduled, however.

Sanitation Commission reports on work

Viewing its accomplishments with "great satisfaction," the Interstate Sanitation Commission has presented its fifth annual report to the governors of the three states represented, indicating that commission activities have resulted to date in the completion of 77 sewage treatment plants and the start of construction on seven others.

Created by compact adopted by the legislatures of the signatory states, under Congressional authorization, the commission represented at its inauguration only New York and New Jersey. Connecticut obtained representation on the commission in 1941, to join in the now tri-state war on harbor pollution.

As a result of recommendations made by the commission and acted upon by the various states and municipalities, the report estimated that four times as much pollution is being removed from the sanitation district (embracing the New York metropolitan area) as there was in 1936. The report noted that all remedial action has been taken without recourse to a single court order.

Seth G. Hess is executive secretary and chief engineer of the commission.

More dams likely on Cumberland River as engineers prepare fund request

With Wolf Creek Dam already under way a rapid start is being made on two more hydro-power projects to supplement power in southeast; three smaller dams projected.

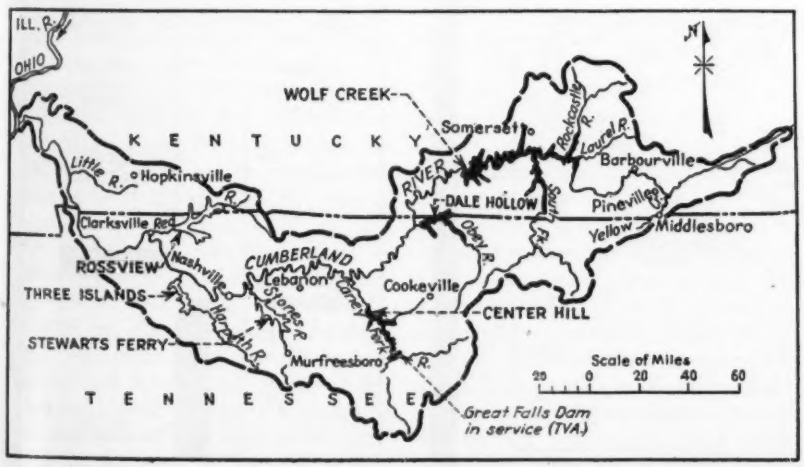
Congress will probably be asked soon to authorize the Corps of Engineers to add two more projects to its power and flood control program on the Cumberland River to supplement the Center Hill and Dale Hollow dams recently put under construction. The Cumberland River program is fitted into the general electric power development program for war industries in the southeast. The projected plan for the Cumberland includes three dams which are not yet authorized, the Rossview, Three Islands, and Stewarts Ferry projects, which would cost, exclusive of power installations, $8,000,000, $8,600,000, and $11,000,000 respectively. However, before these dams can be built, Congress will have to raise the authorized limits of cost of the comprehensive Ohio Valley plan, of which the Cumberland scheme forms a part.

Wolf Creek Dam was first

The Corps of Engineers started its Cumberland River program last summer when it began construction of the Wolf Creek Dam as a straight flood control project at an estimated cost of $35,000,000. In December Congress directed that the project be expedited and that power facilities be installed — 125,000 kw. at first and 250,000 kw. ultimately. The initial power installation at Wolf Creek will add $20,000,000 to the project cost. It is expected that power will be delivered from Wolf Creek in the fall of 1944. Although the dam will be closed earlier, 1944 is the earliest date delivery of power equipment can be made, under the project's A-1-d priority rating, due to huge naval demand for turbines.

At the time Congress authorized addition of power at Wolf Creek it also authorized construction of two more dams on the Cumberland. Center Hill Dam on the Caney Fork River, will be an earth and concrete structure similar to Wolf Creek. It will cost $25,400,000, will have an initial power installation of 77,000 kw. and an ultimate of 105,000 kw. Dale Hollow Dam, on the Obey River, is of gravity concrete design (chiefly because of the absence of suitable earthfill in the neighborhood). It will cost $14,500,000, and will generate 30,000 kw. at first, 45,000 kw. later. This dam will be finished in about a year, but it will be two years before turbines can be obtained.

The third supplemental defense appropriation, which provided for these three power projects also, for the first time, authorized the Corps of Engineers to award contracts for river and harbor work by negotiation. This new authorization was used on the two Cumberland Dams, and served to get them under construction very quickly. The appropriation was signed Dec. 17, and by the first of the year construction of Dale Hollow had started under a letter of intent although award of contract, to Morrison-Knudson Co. of Boise, Idaho, was not made until several weeks later. The contract for Center Hill had also been awarded by mid-January jointly to Massman Construction Co., Hamilton Construction Co., and Metcalfe Construction Co., all of Kansas City, Mo.



Cumberland River watershed where new hydro-power dams for Southeast war factories are being rushed by Corps of Engineers—Black reservoirs are underway.

Saving of welding wire by proper use urged

ELECTRODE material must be conserved by efficient use if welding is to contribute its maximum advantage to the war effort, reports Clayton B. Herrick, welding engineer, Lincoln Electric Co., Cleveland, Ohio. There are a considerable number of factors which affect the most efficient use of electrodes, and Mr. Herrick urges that widespread account be taken of them. Selecting the right type of joint and being careful about fit-up are two ways to conserve weld metal. Then there is the important point of choosing the correct type of electrode, being sure that it has and maintains a uniform coating, that its physical properties are suitable, that it is fast flowing, and that it causes minimum splatter and slag loss.

Wherever possible electrodes that produce flat beads should be used; otherwise not only is metal wasted but time is consumed in removing excess metal. The electrode should, of course, be used according to the procedure recommended by the manufacturer.

It is particularly important to choose the right size electrode, the largest diameter wire that can be used effectively producing the greatest saving; this saving, for example, runs up to 40 percent per pound deposited when ¼ in. instead of $\frac{5}{32}$ in. size is used. Furthermore, as long electrodes as possible should be used, to reduce the number of stub ends. These stub ends should be as short as possible, 2 in. or less, since a ½-in. difference in a stub end saves about 3 percent on an 18-in. rod. Stub ends should, of course, be salvaged.

Another admonition is to refrain from bending the electrodes; this generally unnecessary habit will waste from ¼ to ⅓ of the electrode. Use electrodes straight. Finally, modern welding generators, with greater efficiency and capacity than older models, will also produce more inches of joint per electrode.

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Tacoma Bridge steel sold

The first sale of parts of the Tacoma Narrows suspension bridge, which was wrecked by wind Nov. 7, 1940, were made late last month. A thousand tons of girders, 175 tons of miscellaneous steel and 17,600 ft. of suspender rope brought $62,925. The shock absorbers, 6 tons of metal, were sold for $276, and the cable sockets, 8½ tons, for $317.

Inasmuch as the purchasers paid from $40 to $50 a ton for the material, they apparently bought it for salvage and not for scrap, for which the price ceiling is in the neighborhood of $15 a ton. The two towers, each of which weighs 1,926 tons, and the cables, whose combined weight is over 7,600 tons, are yet to be sold.

OBITUARY

ALBERT J. WISE, 70, member of the engineering firm of Howe and Wise and one of the developers of two nationally-used highway construction methods, died at Houston, Texas, Feb. 3.

HARRY J. DEUTSCHBEIN, 62, president of the H. J. Deutschbein Co., engineers, died Feb. 8 at Miami Beach, Fla. Mr. Deutschbein was a former deputy city engineer of Albany, N. Y., and was president of the Foundation Company, New York, until he formed his own company in 1929.

FRANK J. WICKES, 85, vice-president of the Wickes Engineering & Construction Co. of Des Moines, Ia., died Feb. 1 at Altadena, Cal.

EUGENE L. GIBNEY, electrical engineer of the Seattle lighting department, died Jan. 24 in Seattle. He had been with the department since 1922.

FRANK SCHUBERT, 47, assistant general manager of the Houde Engineering Corp., of Buffalo and internationally known as an industrial engineer, died at Buffalo Feb. 4.

RICHARD WILLIAMS, an erecting engineer for the Nordberg Mfg. Co., Milwaukee, died recently in a hospital there.

HARRY D. BODINE, 48, head of the map engineer's department of the Indiana State Highway Commission since 1919, died Feb. 3 at his home in Indianapolis.

JOHN W. FERGUSON, chairman of the board and former president of the Manufacturer's Association of New Jersey and President of the John W. Ferguson Co., Paterson, N. J., building contractors and engineers, died Feb. 4 at his home. He was 81 years old.

IGNACIO L. BANCALARI, 56, prominent Mexican civil engineer and a former official of the National Irrigation and chairman of the Mexican section of the International Waters Commission, died Jan. 26 in Mexico City.

PHILIP LEFORT, 80, a retired building contractor of Providence, R. I., died at No. Smithfield, R. I., Feb. 5.

AUSTIN BLAKE MASON, 56, formerly a Boston construction engineer and research associate at the Harvard Graduate School of Engineering, died at Weston, Mass., Feb. 5.

CONTRACTS AND CAPITAL

HEAVY ENGINEERING construction for the week, $104,893,000, tops the $100,000,000-mark for the fourth consecutive week, but is 35 percent below the total for a week ago.

Public construction for the week is 30 percent lower than in the preceding week, and private is down 63 percent. State and municipal work tops a week ago by 24 per cent, but federal construction is 34 percent lower, and is responsible for the public decline.

The current week's volume brings 1942 construction to $894,763,000, an increase of 15½ percent over the total for the opening seven-week period last year. Private work, $80,711,000, is 67 percent below the period a year ago, but public construction, $814,052,000, is 53 percent higher as a result of the 98 percent gain in federal volume.

In the classified construction groups, gains over last week are in waterworks, sewerage, bridges, earthwork and drainage, and streets and roads. Increases over the totals for the short 1941 week are reported in waterworks, bridges, earthwork and drainage, and unclassified.

New capital for construction purposes for the week totals $542,291,000, an increase of 5 percent over the volume for the 1941 week. The current week's new financing is made up of $7,461,000 in state and municipal bond sales, $3,625,000 in corporate security issues, $2,500,000 in RFC loans for industrial expansion, and $528,705,000 in federal construction funds from the Naval Appropriation Act.

CONTRACTS
(Thousands of dollars)

	Week Ending Feb. 13 1941	Feb. 5 1942	Feb. 12 1942
Federal	$61,237	$129,900	$85,149
State & Municipal	14,701	9,543	11,891
Total public	$75,938	$139,443	$96,950
Total private	20,408	21,647	7,946
TOTALS	$96,346	$161,090	$104,896
Cumulative 1942 (7 weeks)			$894,763
Cumulative 1941 (7 weeks)			$774,626

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1941 7 weeks	1942 7 weeks
NON-FEDERAL	$107,815	$125,924
Corp. Securities	37,365	28,190
State & Mun.	56,787	83,965
U.S.H.A. loans	12,043	
R.F.C. loans	1,620	13,829
FEDERAL	$509,000	$978,705
TOTAL CAPITAL	$616,815	$1,104,629

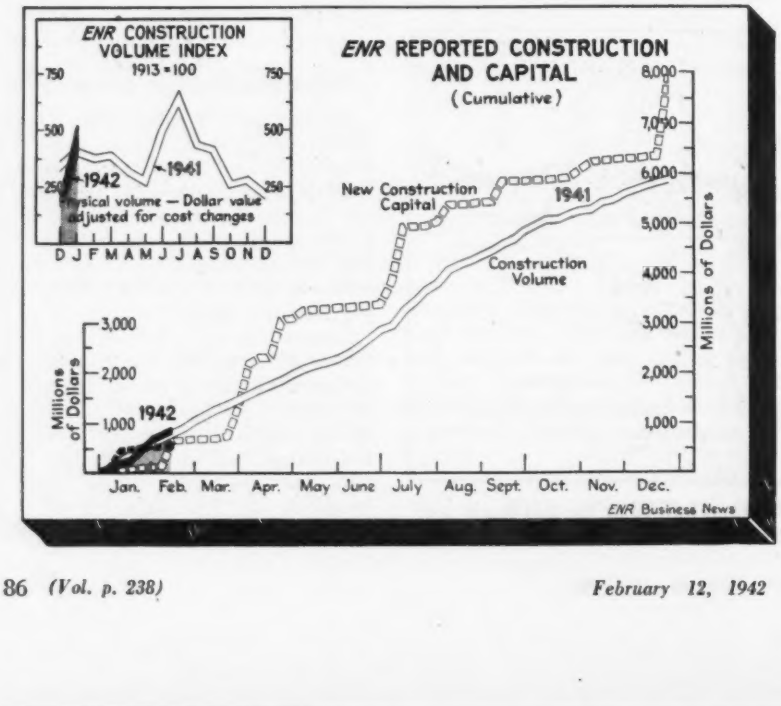
ENR INDEX NUMBERS

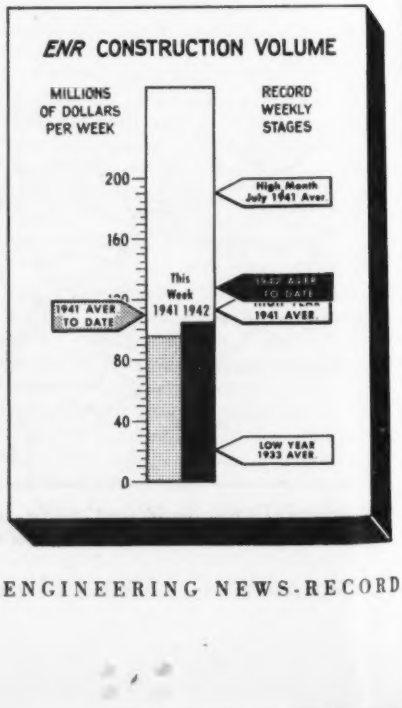
Index Base = 100		1913	1926
Construction Cost	Feb. '42	269.41	129.51
Building Cost	Feb. '42	218.44	118.08
Volume	Jan. '42	503	221

FHA MORTGAGES

	Week Ending Feb. 8 1941	Jan. 31 1942	Feb. 7 1942
Selected for appraisal			
Title II	$22,535	$14,373	$14,840*
Title VI		$16,588	$17,490*

* Subject to revision.





Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

On Increasing Unit Stresses

Sir:—A letter from C. P. Disney (*ENR*, Jan. 1, 1942, p. 9) suggested the arbitrary increase of allowable unit stresses for steel up to as high as 28,000 psi. for "very determinate static load." The qualification quoted is very important.

The present A.S.T.M. Standard Specification for Bridge and Building Steel, A-7, calls for a minimum yield point of 33,000 psi. (not an "elastic limit" as stated by Mr. Disney, who also mentions a value of 35,000 psi.). In the 1941 *Proceedings* of the A.S.T.M. the writer, in collaboration with Francis A. Opila, reported on a number of compression and tension tests of carbon silicon, and low-alloy steels. The eleven samples of A.S.T.M. A-7 carbon structural steels that were included gave the following tension test results when tested in the direction of rolling:

(1) Six out of eleven samples had upper yield points below 33,000 psi., the lowest value being 29,500.

(2) Eight out of eleven samples had lower yield points below 33,000 psi., the lowest value being 28,000.

These tests were made at very slow speed under careful laboratory control, and it is possible that the standard control or mill tests might have indicated all as quite satisfactory. Although the upper yield point is frequently the accepted criterion of yield strength, the lower yield point is structurally more significant. The structure under static load gets no advantage from the speed of test.

In considering the classification of old bridges it should be remembered that up to 1921 the A.S.T.M. allowed a minimum yield point of 27,500 psi. for bridge steel. This was raised to 30,000 psi. in 1924, and about ten years later was further increased to 33,000 psi. Again, these are control-test requirements. These facts are recognized by Committee 15 of the A.R.E.A., which require a complete history of the steels used to be available in the case of any old bridge that is reclassified. Otherwise, coupon tests of the material from the actual structure must be made. Allowances are made for impact, braking forces, lateral loads, and other factors. Only then is 0.8 of the yield point allowed in rating the bridge, and in the case of bessemer steel, only 0.7.

Mr. Disney recognizes that arbitrary increases in unit stresses cannot be made in the design of compression members without a full knowledge of the elastic stability problems which are involved.

The consideration of fatigue properties also emphasizes the importance of applying increased unit stresses only in the case of temporary structures, particularly so in the case of railroad bridges. In Bulletin 302, University of Illinois, W. M. Wilson and F. P. Thomas state "The fatigue strength of plates in a riveted joint of balanced design subjected to a cycle in which the stress varies from zero to a maximum tension (based on 2,000,000 cycles), is approximately 26,000 psi. (calculated over the net section). This value is practically the same whether the plates are of carbon steel with a static strength of 80,000 psi. or of nickel steel with a static strength of 99,000 psi."

Even if the buckling and fatigue problems are avoided, increases in allowable unit stresses should imply a shift from a factor of ignorance to a load factor or true factor of safety in structural design. Hence, the engineer who uses such increased stresses should always ask himself the question "Has the factor of ignorance decreased in inverse ratio to the increase in design unit stresses?"

Structures do fail occasionally. Such failures are not always due to overstressing, but it is nevertheless true that all structures, in the strictest sense, are overstressed. Centuries ago structures were built without the least knowledge of stress or strain. They were satisfactory if they stood up and unsatisfactory if they fell down. This procedure of design might well be termed "limit design," to use the current phraseology, and while we know a lot more today about *how* to analyze stresses in structures it does not follow that this knowledge is usually put into practice. More often than not it is entirely impractical, if not impossible, actually to make a complete stress analysis of a structure. The important thing has been *to build and use* a structure, not to analyze it.

The simple, approximate formulas for average or so-called maximum stresses which are used today do not tell anything about the localized maximum stresses in fillets, near welds, at rivet holes, and at other points of discontinuity. Nearly all engineering structures are stressed beyond the yield point in localized regions but the conservative designs of the past have usually given structures in which some of the structure, but not too much of it, was stressed beyond the yield point, and in which overstressed material at least did not usually contribute to the failure of the structure. If the design unit stresses are continuously increased, the point will eventually be reached when too much of the structure is stressed beyond the yield point. Excessive deformations, if not failure, will result.

In an article entitled "Design Economy By Connection Restraint" (*ENR*, Oct. 10, 1940, p. 484), the writer, in collaboration with Robert A. Hechtman, proposed a simplified design method to take account of the partial restraint afforded by standard or near-standard building connections. Such a design method is just one example of an attempt to effect economy by increased accuracy in design calculations rather than by arbitrary increase in unit stresses.

The writer is not arguing for or against an increase in unit stresses. But if stresses are increased arbitrarily without increasing design accuracy, the inevitable result will be an increasing number of failures. Allowable stresses and design formulas in our best specifications are based on many years of trial and error. Many considerations have guided their formation, and few of these meet the eye upon a casual reading. Sudden changes should not be made without a full knowledge of the approximations and assumptions involved, nor without increased accuracy in the procedures that guide the design.

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EDITORIALS

VOLUME 128 NUMBER 7

February 12, 1942

This Issue

ROAD BUILDING IN WARTIME must be governed by different objectives, may perhaps have to be carried on by different procedures, will need to be guided by what we have been able to accomplish in the months just passed. This annual highway number is planned to make this many-sided task easier. A group of articles emphasizes modern construction practices that will keep wartime roads up to necessary standards. A state-by-state record of 1941 accomplishment and 1942 possibilities provides a base for future planning. It is an issue of more than usual significance to every reader, highway specialist or not.

Typical Sideshow

HEATED DISCUSSION of dancing, actors and art in the Office of Civilian Defense, which resounded in the halls of Congress last week, completely missed the significant point that placing extraneous activities in an organization charged with a mission quite foreign to them is a common practice of the present administration. It is only necessary to recall how the NRA was tacked onto the first pump-priming public works plan, completely changing its character and wrecking it; how the Public Works Administration began with definite promise, only to have the WPA introduced to scuttle it; how even the original WPA idea of putting people to work on construction soon blossomed out into a great social experiment with its art and writer divisions. A few months ago a Senate committee held hearings on a bill to provide funds for advance designing of construction projects for post-war public works, only to have government witnesses, with complete cooperation of the Senators, drag in the question of funds for education, nutrition and other social betterment schemes. It is, therefore, not surprising to find the OCD, whose function is to protect civilians from bombs, branching out into civilian welfare work. Civilian defense wrote Walter D. Binger in these pages recently is "the maintenance, during and between air raids, of cities, towns and the means of transport in a condition as nearly normal as possible." It is, in brief, engineering, and it is not social welfare. If we can't forget social welfare until matters of life and death are taken care of, then it should be set off by itself where its proponents can fritter away their time without slowing down people who know we are at war.

Contractors and Civil Defense

THE CIVIL DEFENSE PROGRAM needs the contractors of the nation. It needs their sound counsel, their "field-work" thinking, their organizing ability and, if the bombs fall, their equipment and services. Because they are trained to meet unexpected emergencies, they can be of invaluable service to defense committees, not only in time of actual need, but also in the advance planning and organization. By offering his equipment and services to civil defense a contractor assures his neighbors and fellow citizens that he stands ready to protect their life and property, to restore damaged facilities, and to relieve human suffering. Such action is not only patriotic but it offers contractors a means of much-neglected public relations that will not soon be forgotten. Missouri contractors have already acted through their local association; others have signified intention to do so. When the entire contractor personnel of the country is pledged to civil defense if, when and where needed, the shock of whatever disaster may come, from within or from without, will be greatly lessened.

The Garbage Man in Wartime

SALVAGE of waste materials from the trash cans of the nation will put a new problem into the laps of municipal administrators. Many are the indications that before long the "garbage man" will be called upon to supplement disposal activities with the more exacting tasks of salvage agent. Already the WPB has announced the construction of three plants for reclaiming tin and iron from discarded tin cans, and test campaigns are underway in some localities to determine methods of collection from householders. Local initiative in a few communities also has resulted in the promotion of reclamation measures, among them being New York City's trial of special Sunday "refuse" collections designed to pick up salvageable material. And in Milwaukee consideration is being given to the installation of electric magnets at the refuse disposal plant to recover tramp iron. Experience in England has shown that prime reliance for effective salvage operations must be placed on established

municipal collection agencies. It is not unlikely that the same conclusion will be reached in this country. Alert municipal authorities, therefore, should be making plans now for the new role that must be assumed by their refuse-disposal service.

Roads in War Days

WHAT ROAD WORK is essential to the nation's war effort? That question is uppermost in the minds of most highway engineers throughout the country. That they have found no answer to it is evident in a review of the diverse programs of state highway departments for 1942 published in this issue. For lack of a federal road policy for the war period, some states have cut their construction programs for 1942 while others, believing that the war effort is to put an added burden on highways, have considerably increased their budgets.

The legislative record of highway planning in the year just closed is one to make all who read it blush. Ten months that should have been spent in active construction of access roads were wasted in needless bickering between Congress and the President, and no one told state highway departments specifically what work on main roads was most needed. The only guide they had was a general instruction to concentrate as far as possible on the strategic highway network. The result was that the states spent their money on those roads of the network that would best meet civilian needs or would serve defense industries within their own borders. Many roads that will be helpful to the nation's war effort were the result, but a much higher percentage of needed roads could have been built with the same money had the War Department been willing to say specifically which roads of the network were needed for *this emergency* and which were not.

A road policy for the war period should be written at the earliest possible date if much valuable time is not to be lost. That such a policy will call for indefinite postponement of much highway construction heretofore planned for 1942 is obvious. On the other hand, complete abandonment of all road building, as is proposed by some having little realization of the magnitude of the task of keeping our highway transportation system in efficient condition, would be the height of folly. In between lies the route by which highway transport can be kept at maximum efficiency without superflous construction.

Maintenance of existing highways is bound to be a major task of the war period, and for every mile of reconstruction that is put off, there will be added charges for maintenance in the months to come. Consequently, it is important that so long as men and materials are available, replacement of old roads that cannot be expected to survive the war period without excessive maintenance costs should be carried forward intensively. And it is here that the state highway departments most need the guidance of a policy formulated by men familiar with the government's war planning. With a labor shortage in prospect in shipyards and munitions plants, highway work that will make that shortage more acute should not be undertaken, yet much is to be gained if the men who ultimately will be needed in those shipyards and munitions plants are employed on road building for as long as they are available. Every mile of new road that can be built now means one less mile requiring high maintenance when our war effort attains its peak.

Another matter on which state highway departments need guidance is in their maintenance planning. Curtailment of private automobile travel now is in prospect due to scarcity of rubber and gasoline. But private auto travel is not a major factor in road maintenance. The major factor is trucking. What state highway officials should know is approximately how much the speeded-up war effort is going to increase truck transportation and over what routes the bulk of that traffic will move. While men and materials still are available, new work can be concentrated on these routes to put them in the best possible condition.

Obviously, these questions cannot be answered by the War Production Board in detail today, but from knowledge of where the raw products of our war machine are produced, where they are fabricated, and where they are to be used, it should be possible to lay down a broad pattern to which the highway departments can work. No road money and no road-building equipment should be used on roads that are not essential to the war effort, but every dollar, every machine and every man that can be spared should be concentrated on the roads that are needed to the end that they be put in condition to serve adequately for the duration.

ENGINEERING NEWS-RECORD
Copyright 1942, by McGraw-Hill Publishing Company, Inc.
WALDO G. BOWMAN, *Editor*. E. J. CLEARY, *Managing Editor*. *New York:* V. T. BOUGHTON, J. I. BALLARD, A. N. CARTER, H. W. HUNT, E. R. DENMARK, *Chicago:* H. W. RICHARDSON. *Washington:* PAUL WOOTON, R. B. COLBORN. *San Francisco:* N. A. BOWERS, *Consulting Editors*, F. E. SCHMITT, W. W. DeBERARD
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An old gravel road salvated through a heavy surface treatment using cutback asphalt and a stone cover.

Trends in Asphalt Pavement Design

Bernard E. Gray
Chief Engineer, The Asphalt Institute, New York

***Contents in Brief**—Application of engineering principles to the design of highway subgrades has greatly reduced the amount of surfacing needed to make the highway suitable for long service. New knowledge of the load-bearing value of these subgrades makes possible a simple determination of what the surfacing thickness should be. Advances in the design of construction equipment, while making changes necessary in specifications for asphalt paving, have contributed to the nation's defense effort by speeding operations and reducing the amount of manpower needed for a given piece of work.*

ASPHALT PAVEMENT DESIGN in recent years has been influenced by a number of developments, most important of which are (1) the growing appreciation of the value of the "engineered" subgrade and (2) the extraordinary development of equipment available for construction. These are particularly important now when it will be necessary to design new surfaces and maintain old ones with the minimum use of transportation and manufactured materials.

The quality of foundations is of such importance that no article on pavement design should be written without definite comment thereon. The word "engineered" is used to distinguish present practice from the old hit-or-miss methods. No greater fallacy ever prevailed than the notion that a good pavement would make up for a bad foundation. Certain inherent qualities must be had in a roadbed, the principal one being ability to undergo temperature and moisture changes with little or no volume change. If the natural soil does not possess this quality then it must be altered, either by suitable treatment or else blanketed with a layer of new material that has this property. The careful soil studies that have been made are now bearing fruit in the form of definite procedures for building subgrades and foundations that will have these required qualities.

The writer spent his early engineering years in the state of Massachusetts, where the practice of building sand-gravel subgrades is of long standing. At first, these gravel subgrades were constructed not so much because of full knowledge of their worth, as because of the fact that gravel was available from almost any roadside bank and was easier to handle than the solid hardpan or rock ledge forming the roadbed. It frequently was more practicable to fill a foot or so with sandy gravel than to make cuts. However, as experience was had in regard to behavior, it was observed that these gravel subgrades were little affected by moisture and frost action, and consequently full support of the roadbed was had throughout the year. Today we define these qualities by such terms as low capillarity, low plasticity index, and others which we apply to Class I soils. However, with all this background, it is still difficult to impress some engineers with the fact that the "engineered" subgrade is the very heart of a road, and that when properly accomplished, the pavement or wearing course becomes almost a secondary item.

Many states have adopted this "engineering" of subgrades as fundamental procedure, notably New England with its stone and gravel foundations, Oregon with its heavy local rock bases and the Southern States with sand-clay, limerock and caliche, and California with "slurry" bases. These are typical examples of utilizing aggregates immediately at hand to produce foundations that have the ability to endure climatic changes without rupture and that can be built cheaply even in depths of from 8 to 18 in. A further step in this development is the attention now being given to careful proportioning of various base mixtures to produce complete uniformity. Gradation is controlled to produce maximum density for any given aggregate and

a weight of 130 lb. or more per cubic foot is easily obtained.

Considerable work has been done with admixtures of either cutback asphalt or emulsified asphalt to complete the waterproofing of such graded mineral aggregate bases and to prevent rise of capillary moisture. Such treatment is particularly effective where aggregates must be imported for a considerable distance, and transportation is an important item. The thickness of base course can be reduced when so treated. However, where aggregates are plentiful, it is more economical to increase thickness and to omit any treatment, the important detail being control of density.

These "engineered" subgrades often will develop sufficient bearing power within themselves to support any static load encountered, either on highway or airport. They are, however, susceptible to softening from surface moisture, and to abrasion from moving traffic. Asphalt treatment of some kind is therefore required to protect the surface, and this will vary all the way from simple surface treatment to hot-mix asphaltic concrete, depending on the type of traffic. For any surface, however, the first step is a prime coat, and in this field a great deal of research has been done. A primer is required to do just one thing—prime. It should not be a surface treatment and hold aggregate; otherwise it will be too heavy. It should penetrate in its entirety and then set up to a firm durable state. As a result of long study The Asphalt Institute recommends MC-0 grade of cutback asphalt for such purpose.

Required thickness of pavement

The maximum highway load is approximately 90 lb. per sq. in.; the heaviest airport loading about 75 lb. per sq. in., under the heavy truck and bomber plane respectively. "Engineered" subgrades will develop bearing power anywhere from 50 lb. per sq. in. up, those of 100 lb. being commonly obtained. With these figures in mind, the question naturally arises as to required cross-section of the asphalt pavement to be placed upon a particular foundation.

Just how thick should an asphalt pavement be to provide needed support under any particular loading? This subject has been studied and debated for years. Various formulae have been suggested, and widely used. It has been evident that the asphalt pavement reacts in direct conjunction with the subgrade, and that its thickness can be reduced as the subgrade becomes greater in strength. This relationship, however, only recently has been determined to an accurate degree, as the result of a careful research by Messrs. Hubbard and Field (Research Series No. 7 and 8, The Asphalt Institute, April and May, 1941).

These studies have shown that an asphaltic concrete slab fails in tension just as any other structural element. However, it can stand deflection of 0.5 in. before breaking, and furthermore fatigue is not a factor as a result of repeated loadings. Soft plastic subgrades may start to move at such deflections under a light load, and so to develop the full strength of a given thickness of asphaltic concrete pavement it is necessary to increase subgrade support. While this of course is true of any pavement structure, it is of great importance in bituminous types due to the ability to construct them in thin section, and to utilize the composite strength of foundation and wearing course to the maximum degree.

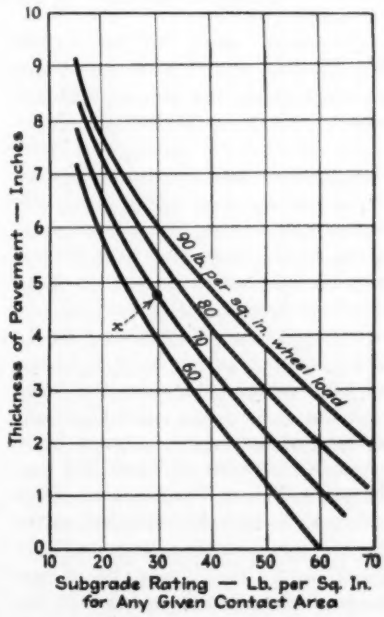
Subgrade bearing value

In carrying on the research a great many tests were made on various kinds of subgrades. Perhaps one of the important conclusions was in answer to the question: What is subgrade bearing value? Well, there is no such thing as *absolute* bearing value. The supporting power of any cohesive soil for any unit load *varies* with the area over which the total load is distributed, and this supporting value must be expressed in pounds per square inch relative to a particular area. Thus, for example, a soil may develop a bearing value of 50 lb. per sq. in. for one tire contact area and a value of 40 lb. per sq. in. for a larger tire contact area. However, by testing a given soil with bearing plates of different diameters, it has been found that a straight line curve developed when bearing in pounds per square inch was plotted against the perimeter-area ratio for the tire contact areas. It is possible, therefore, to interpolate or extrapolate for areas not measured, once two or three different-size bearing area tests have been made (Prof. W. S. Housel, University of Michigan, Engineering Research Bulletin No. 13, Oct. 1929).

The final tests were the actual measurements of the supporting power of asphalt pavements when placed upon different subgrades, and with loads applied over bearing areas of different sizes. Tests have been made on pavements from one inch thickness to nine inches thickness, and the results are shown in the accompanying diagram. The example cited is for a 30-lb. subgrade under bomber loading. For the same wheel load, but by raising the subgrade-foundation support to 50 lb. per sq. in., the required thickness of asphalt pavement would be only 2.2 in. It is cheaper to build first-class subgrades than pavements, and hence the importance of the new technique of really "engineering" subgrades of definite predictable values to support the pavements.

Asphalt construction equipment

At the present time The Asphalt Institute is revising all of its specifications in order to incorporate under "Plant Essentials" the sound improvements that have been made in equipment. These new items, particularly asphalt mixing plants, spreaders and finishers, have so



Required pavement thickness in relation to subgrade support. If for design purposes a wheel load of 70 lb. per sq. in. is selected and the subgrade rating is 30 lb. per sq. in., then the required thickness of pavement is 4.7 in., point X, on the chart.

Compacting a sand-asphalt mix with a tractor-drawn pneumatic-type roller.

speeded operations as to affect the very design of mixes as well as methods of construction. Furthermore, traffic behavior has changed, particularly the pavement reaction under the balloon tire. Comment upon a few items may be of interest.

Asphalt Mixing Plants—The criterion of the merit of a plant is the kind of end-product it turns out. New types of mixing plants are now on the market. Provided they will turn out mixtures within the tolerances set up for other equipment, they are equally acceptable and old specifications should be modified accordingly.

Spreaders and Finishers — The spreading of asphalt mixtures by mechanical means has become standard practice for rural highways and airports. The present shortage of labor will hasten the adoption of such procedure in cities, where previously considerable opposition was encountered. From experience over several years, the following changes in specifications appear desirable:

(1) Mixtures do not need to be heated as hot as for hand finishing, for the interval between the truck and the roller is so short that little cooling of the mixture occurs. Temperatures between 225 and 275 deg. F. are sufficient. Furthermore, when mixtures are machine-finished at the higher temperatures required for hand work, there may be migration of the asphalt cement to the surface under the screed, which will give over-richness to the upper inch of pavement. This is more apt to occur with sheet mixtures than with coarse gradations, but in any case, the difficulty is entirely overcome by dropping the temperature.

(2) Much coarser aggregate gradations can be handled under machine finishing, because segregation is reduced to a minimum. Coarse aggregate mixtures are easier to spread and more compact than sheet mixtures, hence there is a definite trend to their increased use, even on city streets.

(3) There is a definite trend to the use of softer asphalt cements. Coarse graded mixtures have high stability from the interlocking of the large particles and incidentally require less asphalt cement than fine graded mixtures. For heavy-duty city streets, the recommended penetration is between 60 and 85, for rural highways 85 to 100, and for airport surfaces 120 to 150.

Trends in surfacing work

As we start this new year, and contemplate the work ahead, it seems rather definite that new construction will be confined almost entirely to access roads and airports. If these 185,000 airplanes are to be ready in 1943, we must be building runways at a much faster rate than at present. Much of our construction equipment well might be engaged on this work alone. Likewise, the large mileage of access roads must be built to camps, airports, defense industries.

And so what about the existing highways, many of which were planned for relocation or replacement about this time? Well, it is certain that just as the ordinary automobilist must now take better care of his tires, even to the extent of patching them and nursing them along for an indefinite period, so must the road engineer plan for patching and nursing along the great majority of highway miles throughout the land. The order of the day will be "Salvage, Repair, Resurface" rather than the building of any large new mileage of replacement highways. Even roads and streets that by the plans of a year ago were a part of the strategic road map must be deferred until some more favorable period so far as reconstruction or relocation is concerned.

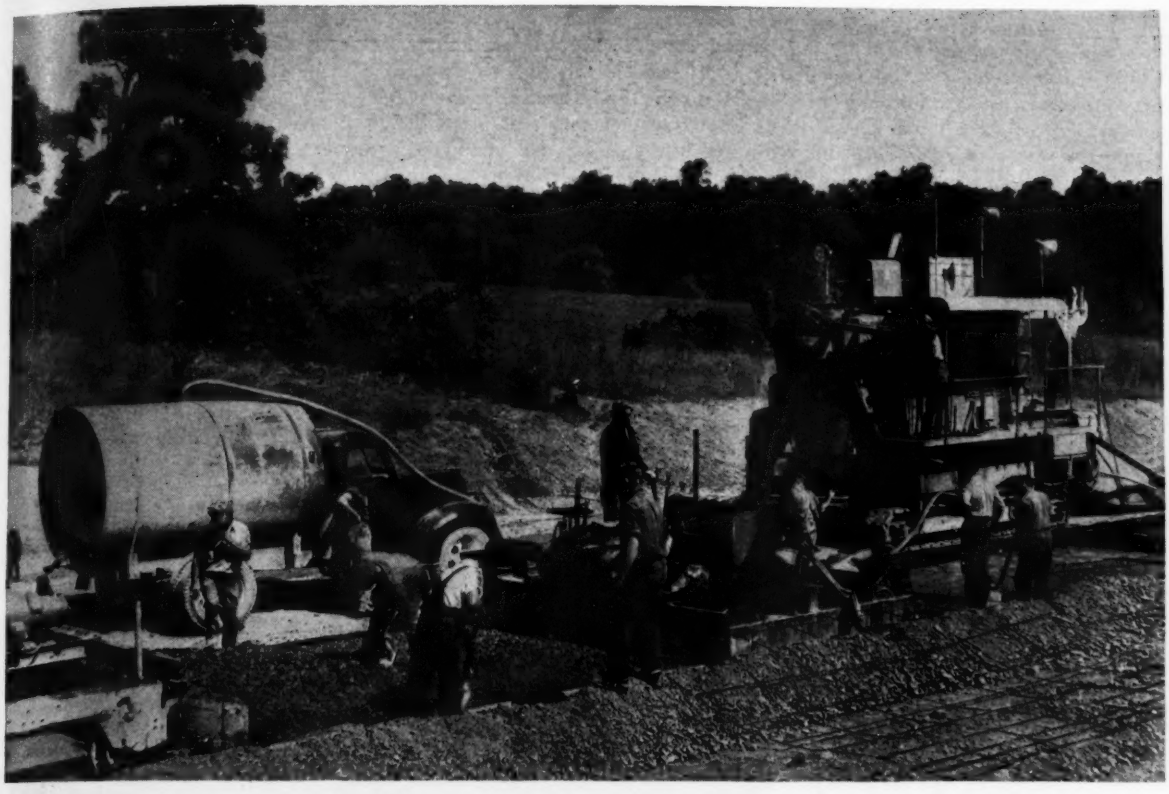
But this does not mean that the highways of America are not one of the most vital adjuncts to the whole system of defense and offense. Anyone with the slightest knowledge of transportation knows that they must be kept at a high state of efficiency. It does mean, however, that the engineer must devote his thinking mainly to problems of maintenance rather than to the one of new construction. There just are not enough materials, or enough men, or enough time to be spared, for any of our present highways to be out of use. But they can be maintained, and the best way is to employ equipment of those kinds that are widely available, and that will not be all required on defense jobs. Surface-treatment equipment and road-mixing equipment will play a large part in keeping roads in good condition, and it will be found in many instances that reconstruction was not so much needed as had been thought. Often a road that is congested when 18 ft. wide becomes entirely adequate for traffic when 24 ft. of surface have been provided. Hence shoulder widening, which does not stop traffic, should be considered in many instances and carried on as a maintenance item.

Summary

The building of the "engineered" subgrade-foundation is the most important development in present-day paving practice. It can be done cheaply and speedily, involving the least use of transportation facilities. Upon such foundations asphaltic concrete surfaces, 2 to 5 in. thick, will carry the heaviest loads.

The extraordinary development of construction equipment has reduced cost and improved quality of all types of asphalt surfaces.

In the immediate future, work on the highway system will be largely maintenance, repair and salvage of present surfaces, with new construction confined to access roads and airports.



Extensive mechanization of concrete placing and finishing has materially improved the quality of the finished pavement.

Trends in Concrete Highway Design

A. A. Anderson
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***Contents in Brief**—A trend away from frills in design of concrete pavements has been accelerated by war conditions. Steel is being reduced or entirely eliminated by minor changes in slab section and by improved spacing of expansion and contraction joints. Treatment of cements to reduce the effect of chemicals and frost action on pavement surfaces shows promising results. Use of these cements makes minor changes in construction procedure necessary but speeds the finishing operations.*

SIMPLIFICATION OF DESIGN by elimination of needless refinements, which up to the present time has been but an undertone, now has become a major theme in highway building. This is partly due to a greater insistence on economy—the design and construction of adequate highways to produce the lowest annual cost—and partly to the present war emergency which requires that all critical materials be conserved. Part of this trend toward simplification is the reduction of steel in concrete pavement to the minimum. This is accomplished by spacing expansion joints at larger intervals and by the use of intermediate contraction joints to form slab lengths which eliminate or control cracking.

On the technological side, there is continued interest in the development of concrete which will be more resistant to the action of chlorides used in the treatment of icy pavements. Very promising are the results obtained in the use of treated portland cements in new construction and in the application of protective coatings on existing pavements.

Concrete slabs may be designed for any load and subgrade condition. With suitable jointing arrangement they may be built with a minimum of steel, or none at all, without sacrificing quality or serviceability.

The normal thickened-edge design, most economical in cost, requires dowels at expansion joints and tie bars across the center joint. Since the only function of distributed reinforcing is to hold the edges of cracks together after they have formed, it is not needed if cracking is controlled through the proper spacing of contraction joints.

The number of dowels required can be reduced by using fewer transverse expansion joints. Experience shows that no load-transfer devices are needed at transverse dummy contraction joints where their spacing is between 15 and 25 ft. (depending on the kind of coarse aggregate used),

and where the number and thickness of expansion joints are limited, so that the pavement is partially under restraint. Under these conditions, the aggregate interlock will provide sufficient load transfer between slabs. However, grooves at dummy joints must be kept sealed against infiltration of moisture and dirt.

From surveys made recently on a large mileage of concrete pavement in Texas, Washington, Oregon, California and Tennessee, built with load-transfer devices at expansion joints, but without similar devices at contraction joints, it was definitely established that no distress resulted from omission of the devices at contraction joints.

Joint spacing

Several state highway departments are carrying on experiments in joint spacing and in the use of load-transfer devices at transverse joints. States which are cooperating with the Public Roads Administration in a series of jointing projects include Oregon, California, Oklahoma, Missouri, Minnesota, Michigan and Kentucky.

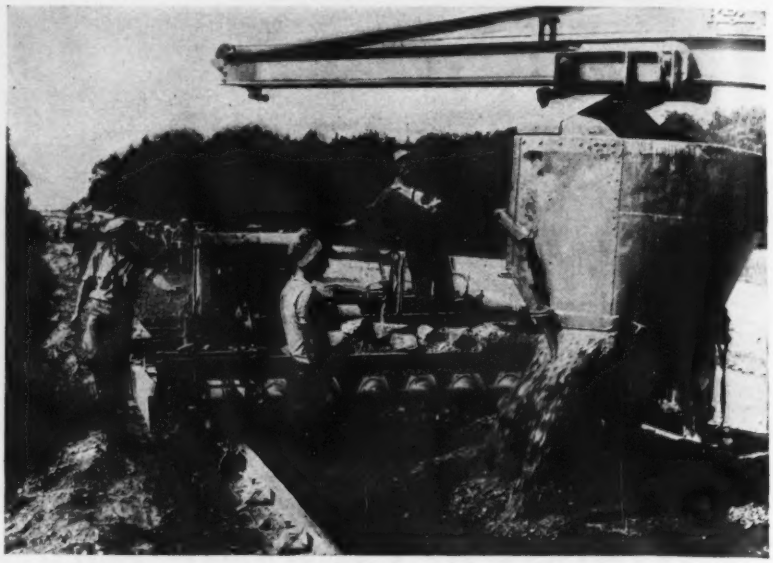
The Minnesota project, which is typical of the experimental projects, has a total length of 8.1 mi. It is divided into 17 sections, 13 of which, with a length of 5.66 mi., are similar to the sections of experimental projects in the other states. The other four sections, 2.44 mi. in length, representing jointing arrangements which the Minnesota State Highway Department wished to investigate, were included to complete the highway link selected for the experiment.

Expansion joint spacings on the 13 sections are about 120 ft. on eight of the sections, 400 ft. on two sections, 800 ft. on two sections. One section a mile in length was built without expansion joints. All expansion joints were dowelled except on the uniform-thickness cross-sections. Contraction joints were placed at spacings of 15 ft., 20 ft., 25 ft., 30 ft., and 60 ft., the last spacing being used only in two sections which were reinforced with wire mesh. Contraction joints were constructed both with and without dowels. All slabs are the state standard 9-6-9-in. cross-section, except two, which are uniformly 7 in. thick.

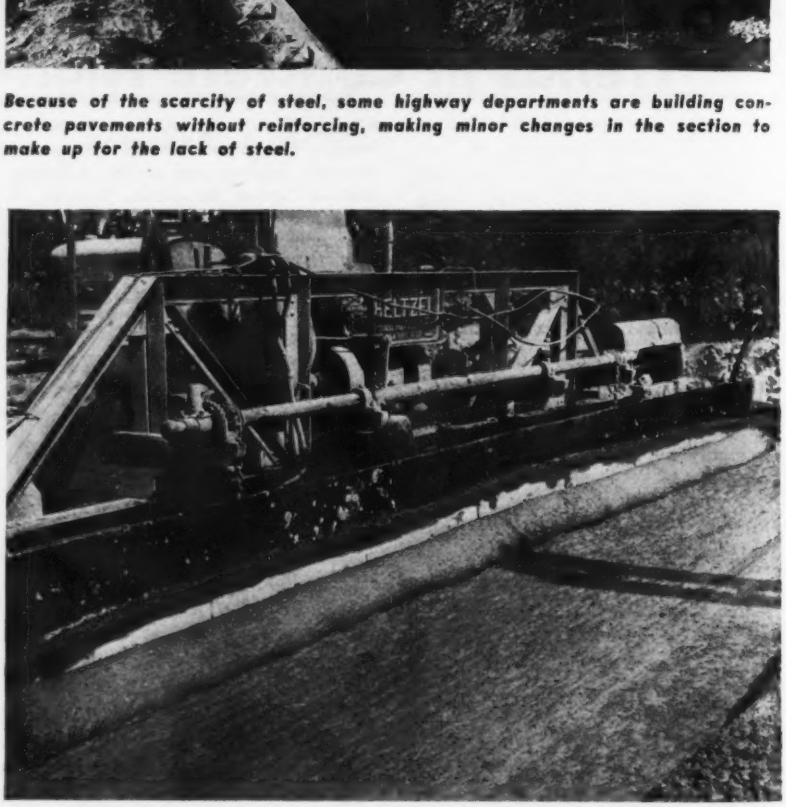
During construction of the project, careful tests and observations were made and recorded on the condition of the concrete, the subgrade, the climate and the methods of placement. Subsequent observations will include the performance of the pavement under traffic, and careful measurement of slab movements at joints at different times of day and seasons of the year. These observations in the field will be supplemented by tests which the P.R.A. will make at its laboratory at Arlington on load transfer at dummy-type contraction joints in slabs which will be subjected to restraint similar to that under which they would serve in the field.

Economy in steel

Should economy of steel be paramount, concrete pavement may be built with no steel at all without sacrifice of quality or serviceability. A thickened-edge design may be built without the use of steel by thickening edges of each traffic lane so that tie-bars are not required and by omit-



Because of the scarcity of steel, some highway departments are building concrete pavements without reinforcing, making minor changes in the section to make up for the lack of steel.



Treated-cement concrete is almost free from bleeding and the surface therefore is somewhat stickier than with normal cement, making minor changes in construction procedure necessary. Finishing must follow placing operations closely.

Patterson Boulevard, Dayton, Ohio, an example of express highway improvement where right-of-way is limited by cost as well as by physical barriers. Each roadway consists of three lanes of portland-cement concrete.

ting expansion joints or by thickening the slab ends at expansion joints so that they will be structurally adequate without load-transfer devices.

Cross-sections of uniform thickness usually are more costly than thickened-edge slabs of equal load-carrying capacity, but under the present shortage of steel they may be justified. Tiebars are not needed at longitudinal joints in pavements of uniform thickness, nor are load-transfer devices necessary in pavements of adequate uniform thickness, although they may be required under some traffic and subgrade conditions to prevent "stepping-off" or faulting of the slab ends.

Treated cements

Oft-repeated applications of calcium chloride or salt to icy pavements, particularly new pavements, have at times resulted in surface scaling. Determination of means for overcoming this scaling has been an important study of the portland cement industry for some time. Investigations have progressed to the point where some preliminary observations may be made.

It has been found that concrete having excellent resistance to the application of salt or calcium chloride can be produced with treated portland cements which are ground with minute quantities of certain fatty or resinous materials. The improvement in resistance appears to be a function of the amount of air entrained in the concrete during mixing. The amount of foaming agent required to produce this effect is small, in most cases ranging from 0.03 to 0.05 percent by weight of the cement. The resulting concrete during placement is cohesive and practically free from bleeding and segregation.

The characteristics of the treated cement require some changes in construction procedure; however, no radical changes are involved. The problem is an everyday one of adjusting construction procedure to the characteristics of the materials, and construction is not made more difficult or costly.

Faster finishing

Since treated-cement concrete is almost free from bleeding, there is little free water on the surface for lubrication during finishing operations. This requires that finishing be carried closely behind placing operations. Thus, finishing can be done with a minimum of delay and avoidance of much overtime work at the day's end.

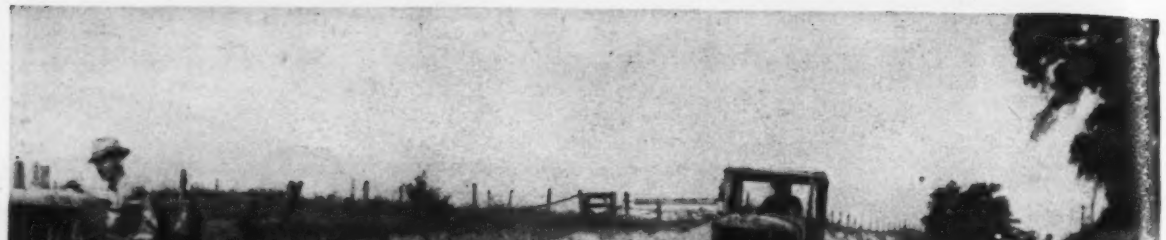
The lack of free surface water makes treated-cement concrete appear to be stickier than normal portland-cement concrete, and it may adhere to the finishing screed, resulting in tearing of the concrete surface. This can be prevented by a suitable adjustment of the transverse oscillations of the screed in its forward motion.

For hand finishing, steel or steel-shod floats are better than wooden floats. All operations should follow closely behind the finishing machine.

Improved resistance found

Accelerated laboratory tests conducted in several independent laboratories have shown some remarkable unanimity in their agreement of the improved resistance of concrete made with treated cements to freezing and thawing tests and to the application of salts. Also, such field results as are now available are in close agreement with the accelerated laboratory tests.

Other experiments in preventing surface scaling through repeated applications of salts are being continued. Existing concrete pavements have been effectively protected by applying to the warm, dry concrete surfaces two applications of boiled linseed oil, following methods and in quantities determined by laboratory tests and field experience. This protection apparently lasts as long as the pavement.



Thorough mixing of the prepared soil with cement is a prerequisite to success in stabilization work.

Stabilizing Soils for Base Courses And Highway Surfacing

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***Contents in Brief**—Low-cost surfacing for highways and airports now is being provided by several methods of soil stabilization. Earlier methods of improving the stability of road surfaces by additions of sand, gravel or other soils have been put on a scientific basis in recent years and now are supplemented by admixtures of cement, bituminous oils and deliquescent salts; experiments with vinsol resin are in progress. Principles applied in the major methods are described.*

SOIL STABILIZATION is not new, for man has sought to accomplish it by various means almost since the first roads were built, but it is only in recent years that scientific methods have been applied to such stabilization. The sand-clay roads of the South are a good example of the earlier type; today we have in addition to these simple mechanical mixes a variety of methods ranging from carefully designed granular combination to those in which stability and permanence have been greatly improved by admixtures of cement or bituminous oils. What the future holds can only be judged by the fact that within recent months encouraging results have been obtained in giving stability to highly unstable silts through the addition of small percents of finely pulverized vinsol resin.

These developments growing out of a scientific study of soil characteristics are having a profound effect on highway and airport developments of today. In highway work, by making it possible to provide a sturdy base course at low cost, the field of usefulness of light bituminous surfacing has been greatly expanded. Similarly, in airport construction, it is now possible to provide runways adequate for all but the most exacting requirements at costs far below what was thought possible a few years ago, this despite large increases in wheel loads in recent years. That this has proved to be a major contribution to the nation's war effort is obvious.

The purpose of this article is to summarize what has been learned concerning the major types of stabilization and to outline current practices in application of this knowledge.

The stability of soil depends on its shearing resistance, which in turn is dependent upon two basic physical properties, internal friction and cohesion. The three main soil constituents, sand, silt, and clay possess these two basic properties in different degrees of magnitude. Sand possesses high internal friction and no cohesion; silt possesses low internal friction and low cohesion; clay possesses very low or a negligible amount of internal friction and high cohesion. Each of these constituents, however, are stable under certain conditions of moisture. Sand is stable only when wet (not saturated), the lack of cohesion being furnished by moisture

films; silts are stable only when moist, the cohesion being furnished by thin films of moisture; and clay is stable only when dry, due to the presence of extremely thin films of moisture which hold the soil particles together with great force.

Mechanical stabilization

It follows from the above analysis of soil stability that it is possible to produce a stable soil by combining the three main soil constituents, sand, silt, and clay in proper proportions. This process is known as mechanical or granular stabilization and is quite economical and satisfactory where proper materials may be obtained locally and where loads are not excessive and climatic conditions not too severe.

In mechanical stabilization, the term soil is used to mean material smaller than 2 mm. in diameter (passing a No. 10 sieve), often referred to as soil mortar; material whose particle size is larger than 2 mm. in diameter is called coarse aggregate.

Stable soils, either natural or artificial mixtures, have been found to follow a definite range in particle size and to possess certain physical characteristics when tested in accordance with standard methods. This discovery or deduction was made after much research, which consisted of sampling and testing many different soil mixtures in actual service, supplemented by tests made on various mixtures of many different materials in a circular track operating under artificially produced field conditions.

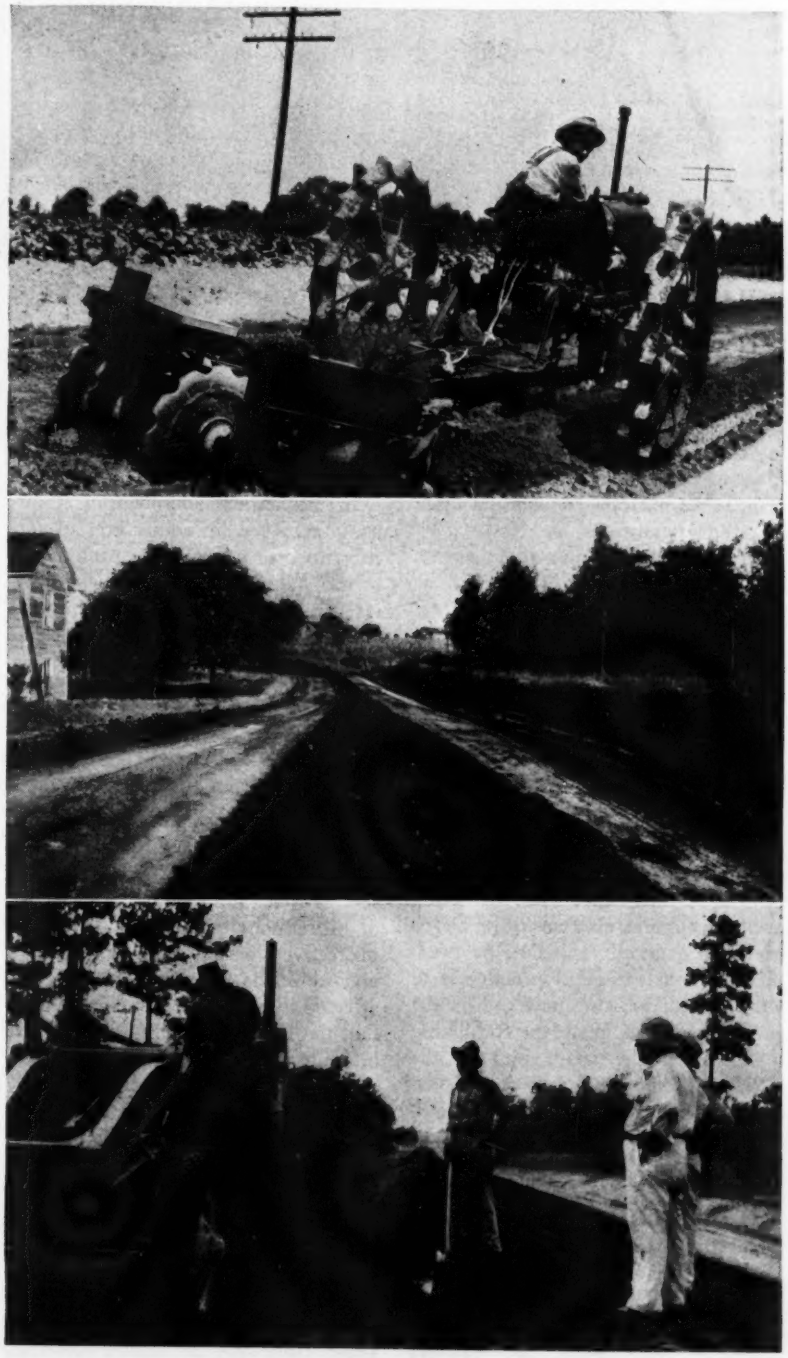
The results of this research made it possible to establish the grading limits and safe physical-test constants for stable soils. Below are the grading limits and physical-test constants of soil mortars (material passing a No. 10 sieve).

	Percent
Passing No. 10 sieve	100
Passing No. 40 sieve	40–70
Passing No. 200 sieve	5–25

When the material is to serve as a base course, the fraction passing the No. 200 sieve should be less than one-half the fraction passing the No. 40 sieve. Material passing the No. 40 sieve should have a plasticity index to exceed 6 and a liquid limit of not more than 25.

In event that the material is designed to serve as a surface course more "binder soil" with greater cohesion is needed, so the fraction passing the No. 200 sieve may be allowed to reach the limit of two-thirds the fraction passing the No. 40 sieve. The material passing the No. 40 sieve should have a plasticity index of from 4 to 10 and a liquid limit of not more than 35.

The above requirements are for "fine-aggregate-type" soils, or those containing less than 40 percent of coarse aggregate (material retained on a No. 10 sieve). This low amount of coarse aggregate is considered to "float" in the soil mortar and adds very little to the stability of the soil mass. It is therefore necessary to design the major ingredient for maximum stability; hence, the above grad-



Pulverizing of the soil (top) is generally done with farm machinery. In bituminous work, soil mixed with the bitumen is placed in a windrow down the center of the highway and then spread with blade graders and compacted with sheepsfoot tampers before the final rolling.

ing limits for soil mortars. When 40 percent or more of the soil is retained on the No. 10 sieve it is called a "coarse-aggregate-type" soil, and the grading limits of the coarse aggregate become more important since these aggregates are in such a quantity that they do not float in the soil mortar. The grading limits of this type soil are given below.

	Maximum size 1 in. (percent)	Maximum size 2 in. (percent)
Passing 2-in. sieve...		100
Passing 1-in. sieve....	100	70–100
Passing ½-in. sieve...	65–100	60–100
Passing No. 4 sieve....	50–75	45–75
Passing No. 10 sieve...	40–60	35–60
Passing No. 40 sieve...	25–40	20–40
Passing No. 200 sieve..	10–25	10–25

The above grading limits are for soils having two maximum sizes of aggregates, one inch and two inches. Both maximum sizes are suitable as base-course materials, but the smaller maximum size is to be preferred in surface courses.

Base courses and surfaces consisting of either natural or artificial mixtures are generally constructed from 6 in. to 12 in. thick, depending upon subgrade conditions and traffic. Of the two soil types referred to above, the coarse-aggregate type is the strongest and generally the most expensive due to the fact that the amount of coarse aggregate (crushed or uncrushed gravel, crushed stone, crushed slag, or other durable coarse material) has to be shipped in or prepared locally.

Field construction methods consist of working the necessary ingredient or ingredients into the existing soil to form a mixture meeting the above requirements. Proper proportioning and thorough mixing are quite necessary and generally are done by road-mix methods. General practice is to windrow the existing material on the road to the sides, place the stabilizing material on the road, pull in the windrows, and mix. Selection of materials that mix easily greatly facilitate the work.

Use of calcium chloride

Mechanically stabilized bases are generally covered with thin bituminous wearing surfaces, while mechanically stabilized surfaces are left untreated or are treated with deliquescent salts such as calcium chloride. This is to prevent development of corduroy or of pot holes and to keep the surface from raveling during dry periods.

Addition of calcium chloride may be considered a supplement to mechanical stabilization. Because of its property of collecting moisture from the air it causes soil to remain in a damp state, which checks the loss of fine material. Also, calcium chloride improves the mechanical characteristics of clay mixes because slightly moist clay in a compact soil acts as a tough, plastic cohesive that it capable of resisting abrasion, while dry clay in the same mixture acts as a strong but brittle cohesive incapable of withstanding abrasion. Soil containing calcium chloride can be compacted to a greater density than soil without it, using the same compactive effort. This is due to the reduction in surface tension of water when mixed with the salt. Use of calcium chloride is generally confined to surface courses. Because it lowers the freezing point of water it is used sometimes to prevent frost action in soil used in highway construction.

Bituminous stabilization

In mechanical stabilization stability is achieved by admixtures of soil constituents needed to produce a proper balance of the two basic physical properties, internal friction and cohesion. In other forms of soil stabilization the attack on the problem is quite different in that the existing unstable soil is treated with some substance to either protect it from the harmful effects of improper amounts of moisture or to change the characteristics of the constituents susceptible to these effects. Bituminous stabilization is a process in which the soil particles are covered with a film of bituminous material to serve as a protective coating against moisture and to act as a cohesive that is unaffected by water. It stands to reason that the thickness of these films must be quite thin for the fine-grained soil constituent, clay, or else the clay particles will be floating in globules of bituminous material, and the mass will have a stability only slightly more than the bituminous material itself. It is also logical that the proper type of bituminous material must be used with the soil to be stabilized. Heavy material should be used with coarse-grained (sandy) soils, while only the lighter materials should be used with fine-grained (silt and clay) soils. Many kinds of bituminous materials such as tars, rapid-curing, medium-curing, and slow-curing cut-back asphalts, and asphalt emulsions are used in bituminous stabilization. Each has its relative merits with particular soils.

Generally, this form of soil stabilization is confined to sandy-type soils due to the ease of mixing the bituminous material with the soil and the quantity necessary for effective stabilization. Clay and silt soils have a preponderance of very small particles which have a relatively large combined surface area and require large quantities of bituminous material. Clay and silt soils are also low in internal friction, which causes loss in stability during warm periods. Coarse material is sometimes mixed with these soils to reduce the amount of bituminous material that would be necessary and to increase the internal friction. It should be noted, however, that the cost of this admixture is sometimes uneconomical.

No standard tests

No standard tests have been adopted to determine the amount of bituminous material necessary to stabilize soils, but many have been devised and used, with more or less success. Essentially, practically all these tests consist of mixing various amounts of bituminous material with the soil and water and submitting compacted specimens of the mixtures to the effects of water, followed by some kind of stability test. Determination of moisture absorbed by capillarity is made by some laboratories, while others immerse the specimens and measure the absorption. These absorption tests should be begun on the specimens only at low-moisture contents, approximating those found to exist in a successfully stabilized base in service. The reason for this is that the soil particles have a greater affinity for water than for the bituminous material and a moisture film surrounds the soil particle which in turn is covered by a film of the bituminous material. When the moisture film is removed, the bituminous film comes in intimate contact with the soil particle, at which time the soil is stabilized. In the beginning it was thought that sufficient water should be added to the soil along with the bituminous material to secure maximum density; however, the trend now is to use as small an amount of water as is possible to secure a satisfactory mixture of the soil and bituminous material. Of

Soil stabilization is used extensively in airport construction. In the work here shown, a light soil that is quite unstable in its natural state is being made serviceable with bituminous oil mixed into the soil by a traveling plant.

course, this means some sacrifices in density, but the amount may be reduced by an increase in compactive effort. It has also been found that the initial density is not so important, since traffic soon corrects the deficiency. The less water used in the stabilization process, the sooner stabilization is accomplished. Projects completed in late summer or early fall are likely to give trouble during periods of low temperatures if sufficient freezable moisture is present in the mass to cause upheaval.

Many tests for measuring the stability of bituminous stabilized soil specimens have been devised and used, such as punch and shear, torsional shear, extrusion, combined compression and lateral displacement, etc., but evaluation of the test values has not been accomplished for the different procedures. For the same type of apparatus and using a definite procedure, test values may be obtained in fair agreement. However, design must be based on arbitrary values for a particular apparatus. These arbitrary values should be correlated with roads in service.

Bituminous stabilization of soil is confined to bases on which some form of surfacing is placed, usually of the bituminous type.

Stabilization of sands by the addition of bituminous materials is not considered soil stabilization. Briefly, the construction of a bituminous stabilized base consists of pulverizing the soil, thoroughly mixing it with the bituminous material, and compacting the mixture. The work may be accomplished by road-mix methods, using harrows plows, graders, etc., or the mixing can be done with a traveling mixer.

Compaction then is obtained by sheeps-foot rollers and pneumatic-tired rollers. After the base has been compacted to a firm unyielding surface, a prime coat of bituminous material is placed on its surface, followed by the surfacing mat. Prime should not be placed on a yielding base, as its instability is due to excess moisture, which will not be able to evaporate if covered with a bituminous membrane.

Thickness of bases

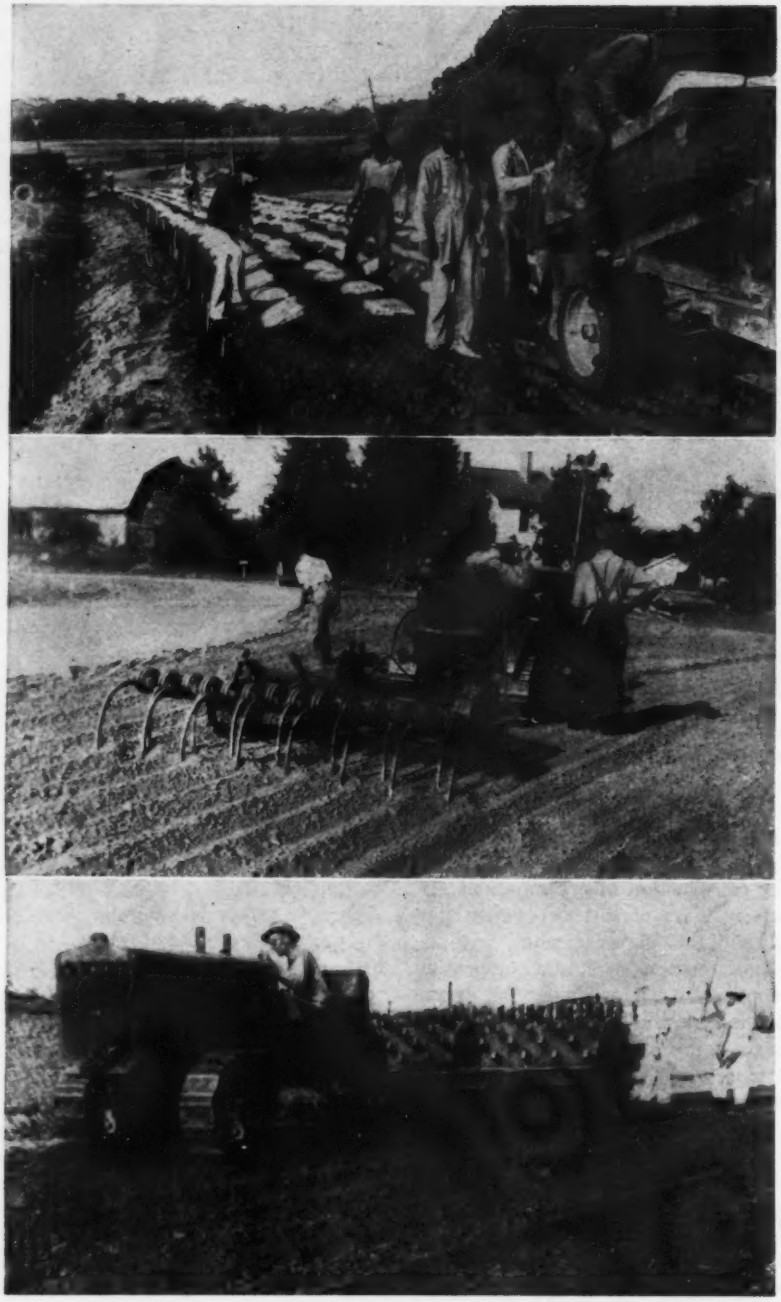
The usual thickness of the stabilized base is six inches. However, thinner sections have been used where excellent, well-drained subgrades were encountered. Bases thicker than six inches are not advantageous unless constructed in two courses. Poor subgrade soils will cause failures in bituminous stabilized bases as well as mechanically stabilized bases.

Bituminous stabilization is quite economical in localities where the soils are rather sandy and loamy. Heavy clay soils require relatively high percentages of bituminous materials or the incorporation of mineral aggregate of a granular nature.

Soil-cement stabilization

As in bituminous stabilization, soil-cement stabilization is used in the construction of bases on which thin surfaces (usually bituminous) are placed. It is reported that the first projects to use this form of stabilization were constructed in South Carolina and Texas in 1933. This early work, while not scientifically designed or controlled, showed great promise and was followed in 1935 by the construction of a project near Johnsonville, S. C., using scientific methods of design and laboratory control. The satisfactory performance of this section of road led to the construction of more than 470 miles of similar road on the highway systems in 26 states; and thousands of square yards have been used in airport runways and parking areas.

While soil-cement stabilization is a comparatively new process, its design



Quite accurate distribution of cement is obtained by careful distribution of bags over the surface to be treated. The bags then are opened and the cement is spread and worked into the soil before sprinkling and compaction.

is based on sound engineering principles and scientific tests. The different types of soil to be encountered are identified, sampled, and tested for durability by freezing and thawing and wetting and drying specimens made of each soil mixed with different percentages of cement. Methods of making test specimens and the durability test procedures have been adopted as tentative standards by the American Society for Testing Materials, (A.S.T.M. D 558-40T, D-559-40T and D560-40T). The percentage of cement necessary for the satisfactory stabilization of each soil is determined from the losses sustained by the specimen composed of that soil and containing that percentage of cement. The limiting values recommended and most commonly used for this determination are as follows:

Subgrade group (P.R.A. classifications)	Maximum loss sustained by specimens after 12 cycles (Percent)
A-1, A-2, A-3	14
A-4, A-5	10
A-6, A-7	8

While some highway engineers question these limiting values, it is generally conceded that they are at least adequate because bases designed using them in the determination of the amount of cement necessary for stabilization have given satisfactory service. It may be possible to use greater maximum losses in different localities, but these limits will have to be determined experimentally for each locality. Some work along this line is already in progress.

Field methods

Briefly, construction of a soil-cement base consists of pulverizing the soil to the required depth, incorporating and thoroughly and uniformly mixing the specified amounts of cement and water, thorough and uniform compaction without laminations for its entire depth, and shaping. Much has been written outlining various methods used in performing these operations. Any one of these methods is good if it accomplishes the desired result, as each operation is important to a good base. Pulverizing the soil to the degree where the lumps are small and are few in number is essential as these lumps will not be treated with the cement and will act as raw soil within the soil-cement mass. A small amount (not over 20 percent) of small lumps (less than 1 in. in size) will not prove detrimental as they will be completely surrounded with the treated material and their instability will be completely absorbed by the stabilized soil. Thorough and uniform mixing of the specified amounts of water and cement to the required depth, followed by uniform compaction without laminations to at least 90 percent of the required density, are also essential to the production of a good base. The percentage of cement necessary for stabilization is determined from results of tests made on soil specimens containing this amount of cement and compacted to a definite density. Less cement in any portion of the base or compaction to a density less than that required will produce a base of questionable strength and durability. Cur-

ing of the base for a period of seven days has been found advisable.

Surface courses needed

A surface course is required on soil-cement work. While strong and durable as a base, a soil-cement mixture does not possess sufficient resistance to the abrasive action of traffic to serve as a surface. The base is first primed with a light bituminous material and followed with a bituminous surface mat. The surfacing must be of sufficient density and thickness to withstand the action of traffic and the elements. Some attempts have been made to use the soil-cement base as a surface through enrichment of the top one or two inches with additional cement, but very little success has been achieved along this line. It may be possible to accomplish this with soils of a coarse, granular texture, but extreme care will have to be exercised during construction to secure a perfect bond between the enriched layer and the base or scaling of the enriched layer will occur.

Thickness of the base

The usual base thickness for soil-cement stabilization is six inches, which seems adequate for the loads placed upon roads of the class in which such construction is used. It is reasonable to assume that a greater thickness will carry heavier loads, but whether it will be justifiable to use a heavier base rather than a concrete slab is problematical.

Soil stabilized with portland cement possesses relatively high slab strength. This fact is substantiated by the behavior of soil-cement bases constructed over poor subgrade. Although generally composed of the same soil as is in the subgrade, the cement-treated slab shows no sign of failure due to the faulty grade. This can be attributed to only one thing—slab strength.

Soil-cement in maintenance

Some use has been made of soil-cement in maintenance for patching weak spots in soil-type (topsoil and sand-clay) bases. When the undesirable material in the subgrade occurs in thick layers, it is economical and satisfactory to remove six inches of it and replace with a soil-cement mixture. Unless the area of the patch is large, the soil and cement should be mixed in a concrete mixer or on mixing boards and tamped in place in approximately two-inch layers. The soil-type base should then be placed over the soil-cement patch as soon as possible to protect it from rapid drying-out. Traffic may be allowed over the patched area in from 12 to 24 hours, depending upon conditions. Fairly friable soil containing some clay should be selected for this work to facilitate mixing. The amount of cement required for a soil of this type in work of this nature is 8 percent by volume.

Future developments

It is to be expected that new materials and new methods will be developed in the future as well as improvements on the ones being used today. As noted previously, encouraging results have been obtained with admixtures of vinsol resin, a byproduct of the manufacture of explosives. Powdered resin is mixed with a mild alkaline solution (sodium hydroxide and water), which causes saponification. Soil impregnated with a small amount of this mixture becomes water-repellent. Sands and heavy clay soils do not respond as readily as fine soils and silts. In other experiments clays have been treated with certain chemicals that produce changes in the clay due to adsorbed ions, but stabilization by this means has not yet been put on a practical basis. Abroad, stabilization of clay by burning has been tried, as burning causes clay to lose its plasticity and some other properties and assume the properties of sand. In all these studies, however, the fundamental principles remain the same; any method that increases internal friction and cohesion presents possibilities for research in a field that offers many opportunities for economy, not only in highway work but also in airports, foundations and dam construction.

Protection of Metals From Soil Corrosion

CONCLUSIONS drawn from previous inspections of various metallic and non-metallic coatings exposed to soils are generally confirmed by the results of recent inspections reported by K. H. Logan in a paper (RP1446) in the January *Journal of Research* of the National Bureau of Standards, Washington, D. C. The protection of steel by zinc coatings depends on the thickness of the coating and is not appreciably affected by the kind of base metal. In a group of mildly corrosive soils, a specially applied coating of approximately 3 oz. of zinc per sq. ft. prevented pitting almost entirely for an exposure period of 16 years, the duration of the test. In a group of generally corrosive soils, however, a commercial 3-oz. coating did not entirely prevent pitting over a 2-year period. This result is not consistent with previous tests of heavy zinc coatings in corrosive soils, in which pitting was almost entirely prevented for ten years, the maximum period of exposure. The suggestion is advanced that uniformity is a prerequisite for adequate protection by zinc coatings in soils.

Lead coatings applied to iron and steel have not proved adequate for protection underground. Since the potential of lead is cathodic to that of iron, lead cannot protect iron or steel in the manner that these metals are protected by zinc. As the rate of corrosion of lead is appreciable under many soil conditions, a continuous layer of lead isolating steel from its environment cannot usually be maintained.

A coating of tin was of little benefit in protecting copper from corrosion in soils. Under certain conditions one or more of the tin-copper alloy layers may be cathodic to copper, a condition that would accelerate corrosion.

The condition and protective value of a variety of experimental coatings after limited periods of exposure are discussed. These coatings include various synthetic resins, chiefly of the phenolic group, various types of rubber and synthetic rubber, vitreous enamel, etc. In this group of coatings, a vitreous enamel and two hard rubber coatings provided complete protection for seven years. A phenol-formaldehyde (bakelite) coating, consisting of several coats of bakelite varnish with each coat baked on, provided satisfactory protection for two years, the extent of the exposure.

Widening a Steel and Concrete Bridge

***Contents in Brief**—In South Carolina, roadways on two steel through-truss spans and thirteen concrete deck-girder spans were widened from 18 to 24 ft. without reduction of their capacity below an H-15 loading. Use of a concrete-filled steel-grid floor on the steel spans produced dead-load stresses in the rebuilt truss members less than those in the original structure. The widened truss spans were carried on cantilever caps on the old piers. Under the widened concrete girders the piers were increased in height, while other approach spans were completely replaced by spans at the higher level of the rebuilt approach highway.*

In a Road Modernization program carried out in South Carolina last year, a 20-year old bridge across the Wateree River on U. S. Route 76 east of Columbia was widened from 18 to 24 ft. without reduction in the load capacity of the bridge. Also included in the undertaking was a change in the approaches to raise their grade above high water and replacement of the timber approach spans with concrete spans. Each way from the bridge, across the four-mile-wide flood plain of the river, the approach highway also was raised to the higher level.

The original structure consisted of two steel through trusses of 168-ft. span, 25 concrete deck girders of 36-ft. 6-in. span and about 400 ft. of creosoted timber trestle. Twelve of the twenty-five concrete spans that were originally below the new and higher grade were removed in the reconstruction work and new spans were constructed on raised bents, most of the reinforcing steel in the old spans being salvaged for use in the new ones. The remaining thirteen approach spans were near enough to the new grade to permit adjustment by minor increases in the pier heights, the spans being jacked up to their new position. The total length of the bridge is 1,312 ft. of which about 775 ft. was widened in this operation and the remainder was rebuilt.

The two steel truss spans are over the main river channel and rest on concrete piers, about 50 ft. high, which are supported on untreated timber piling. The structure was originally designed for a 6½-in. thick concrete floor, an asphalt surfacing weighing 20 lb. per sq.ft., and a live-load allowance of 66 lb. per sq.ft. (similar to load of 15-ton truck) plus an impact allowance of 25 percent of the live load. A working stress of 16,000 lb. per sq.in. on the net section of steel members was used.

Trusses sufficiently strong

The new design is based on using a 3-in. thick concrete-filled steel-grid deck with a wearing surface weighing 15 lb. per sq.ft., which is to be added later, thus giving a dead load per panel for the new design to about 90 percent of the original. Live load, computed for an H-15 loading according to standards of the American Association of State Highway Officials, is higher than the original live load, but the combined unit stresses are within the maximum allowed for the steel in the present specification of the A.A.S.H.O. Stresses in some secondary members are considerably increased, but the members are well able to carry them because their size was determined by considerations other than net stresses.

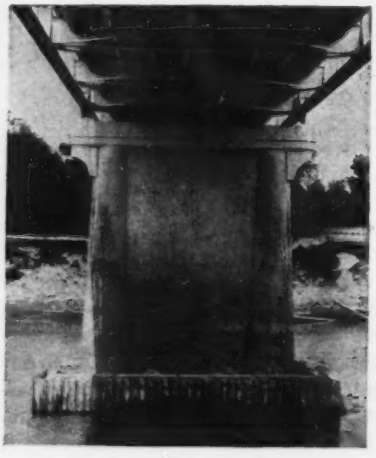


Fig. 1. Piers carrying the steel trusses were widened by cantilevered steel beams encased in concrete.

Pier reconstruction

Bids for construction were taken with an alternate of enlarging the concrete columns of the dumb bell-shaped piers down to the footings or widening the pier caps with cantilever steel beam encased in concrete. The cantilever beam scheme was bid lower and adopted. A completed cap is shown in Fig. 1. The increased load on the foundations is roughly one ton per pile, which is considered conservative in view of the fact that no settlement had been observed in the piers.

The first construction operation was to lighten the existing trusses by removal of the concrete floor, the slabs being broken up with pneumatic hammers. Temporary timber bents, with posts resting on the ledge of the existing footings, were set on each side of the piers to support the spans. Jacks raised the spans sufficiently to permit placing some of the new floor stringers on this falsework, spanning over the top of the piers and under the end floor beams of the old trusses. Lowering the jacks transferred the truss load to the timber bents, permitting removal of the existing concrete cap on the piers.

In this demolition the reinforcing steel projecting from the concrete was retained to provide bond with the old work. Other reinforcing steel was salvaged for re-use.

The old caps were cut down to an elevation about 6 in. lower than the bottom flanges of the new cantilever beams, and concrete seats over the pier shafts were cast and ground to the exact elevation of the bottom of the beams to be used in widening the pier caps. Then the beams were set and encased in concrete, the encasement being formed to resemble a cantilevered pier cap.

Upon completion of the pier caps, rails were laid on them to provide a

Fig. 2. The two interior beams and slab are old concrete; exterior beams and parts of the slab are new.

track for pushing the spans sideways. The entire span then was lowered to the rails and jacked one way to a position such that one truss was in its permanent position. Subsequently the floor beams and bracing were cut to permit widening of the structure.

For the widening, heavy wooden frames, Fig. 3, at right angles to the trusses, were set at about the quarter points of the span to prevent the tops of the trusses from tilting and yet permit the trusses to be moved apart. These frames were diagonally braced and were fitted snugly against both the top and bottom chord thus keeping the individual trusses from tipping much out of the vertical when the sway bracing was removed.

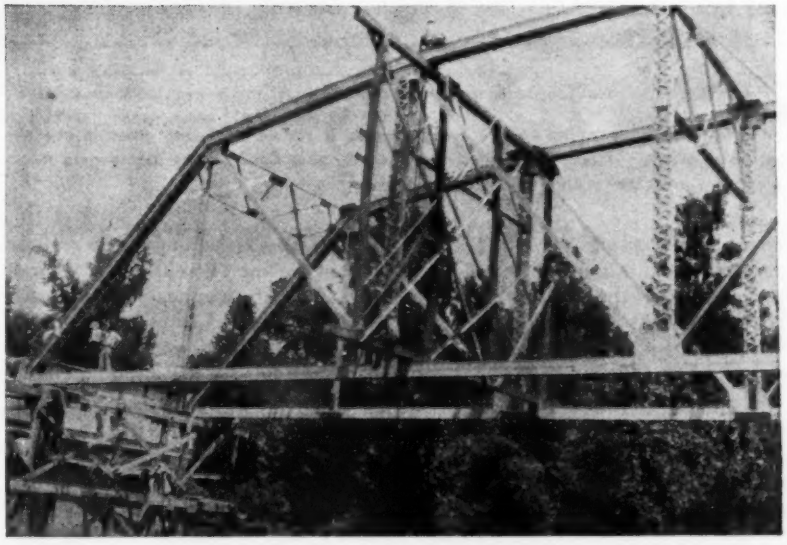


Fig. 3. A vertical wooden frame, fitted snugly between the top and bottom chord members, prevented the trusses from tilting when cut apart for moving.

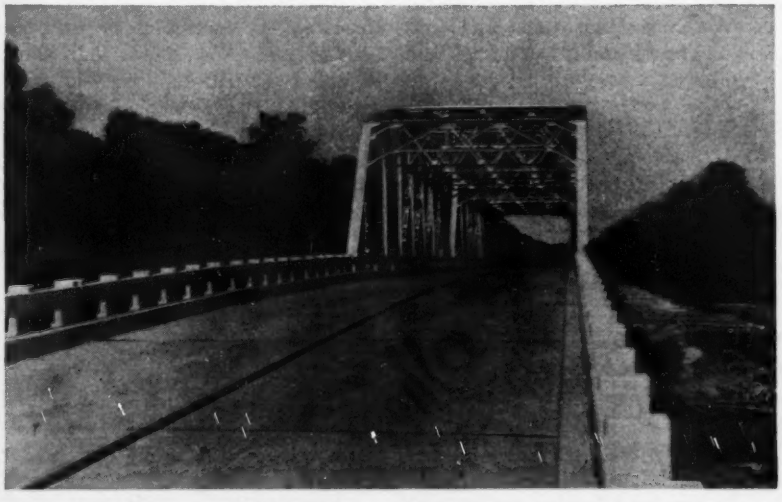


Fig. 4. South Carolina highway bridge widened from 18 ft. to 24 ft. in road modernization program.

All of the floor system and the top and bottom lateral bracing were removed from the truss span. The portal bracing and sway frames were cut at connection points near the center, a part of the struts being left attached to each of the trusses. The one truss not in final position was then shoved out by jacks to its new position and a shop-fabricated section was inserted in the top sway frames, then riveted and welded in place. The portals frames were handled similarly.

The floor beams were entirely replaced with new material of the proper length and strength to carry the H-15 load on the wider roadway. Old connections to the vertical members of the truss were used, the bottom elevations of the floor beams being retained despite the use of 4-in. deeper beams. The original stringers were used at slightly closer spacing and were supplemented by two lines of new stringers to carry the different type of floor. The bottom laterals were salvaged, spliced out by welding and reattached to the original gusset plates by welding, but the top laterals were replaced with new material.

The new roadway deck is a 3-in. deep I-beam grid construction with concrete placed flush with the grid surface. The small beams of the roadway grid are at right angles to the center line of roadway and span 3 ft. 3 in. c.c. of stringers.

To improve the protection for truss members which are exposed to local impact from passing vehicles, a heavy

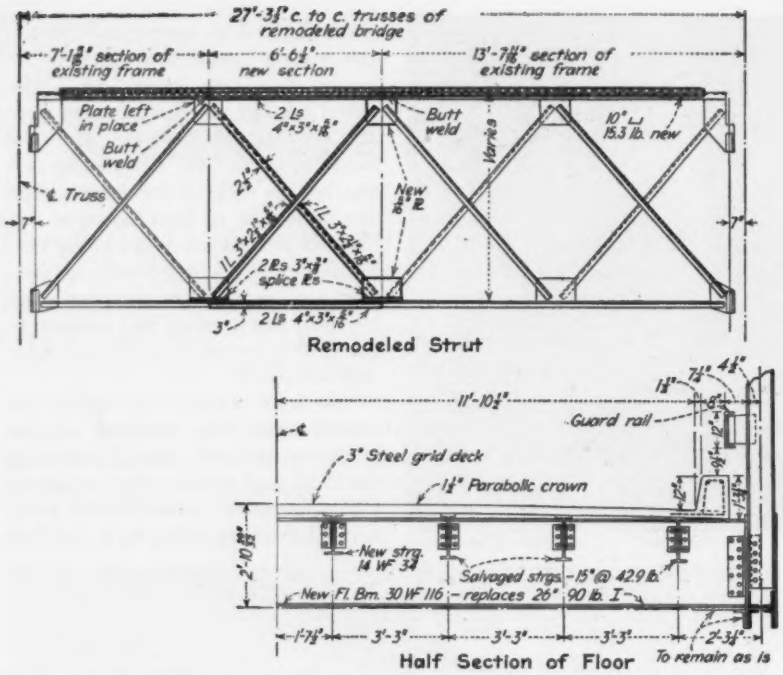


Fig. 5. New steel added to the sway frames is shown by heavy lines in the remodeled strut. In reconstruction of the deck, new floor beams and a grid floor were the principal steel requirements.

channel rail replaces the original pipe rail on the truss spans. The new rail matches that of the concrete approach spans in height and width.

Widened concrete deck girder

A section of the original concrete deck-girder spans and their final shape are shown in Fig. 6. Widening was accomplished by removing the outer beam on each side of the center line and replacing it with an integrally placed new beam and cantilever section of roadway, thus increasing the width 6 ft. to provide a 24-ft. roadway. At the start of the widening, chipping hammers were used to cut a groove along the under side of the slab at the line where the concrete was to be cut for removal of the outer section. The slab was then cut through longitudinally with pneumatic drills operating on the deck, the slab reinforcing steel being carefully preserved to splice to the new reinforcing.

It was considered desirable to replace the old asphalt paving (2 in. thick) with a concrete wearing surface so that the widened spans would not have the appearance of patchwork. The new concrete paving is between 2½ in. and 3½ in. thick with ¾-in. aggregate and is reinforced with wire mesh. It was poured integral with the new exterior beams and slabs. As a good bond with the old slab was desired to prevent cracking of the thin layer of new concrete paving, the old asphalt paving was removed and an attempt was made to dissolve the remaining asphalt with gasoline; but when that treatment did not remove the asphalt as completely as was desired, an air hammer was used to remove about $\frac{1}{16}$ in. of the old concrete leaving a perfectly clean surface. This surface was saturated with water for some time and before the concrete was placed a cement paste was applied and scrubbed into the old surface. This was immediately followed with the concrete while the paste was plastic. Several months after the bridge was opened to traffic, an inspection to determine the effectiveness of this method of securing bond with the old pavement showed only one slight crack in the concrete paving.

The reconstruction and addition of the new spans was done by Jos. W. Barnwell, Jr. of Columbia, S. C., for whom L. J. Morgan was in charge.

The general planning and construction supervision were handled by the South Carolina State Highway Dept. under W. J. Gooding, Jr., bridge engineer. A. T. Clarkson was resident engineer on the work.

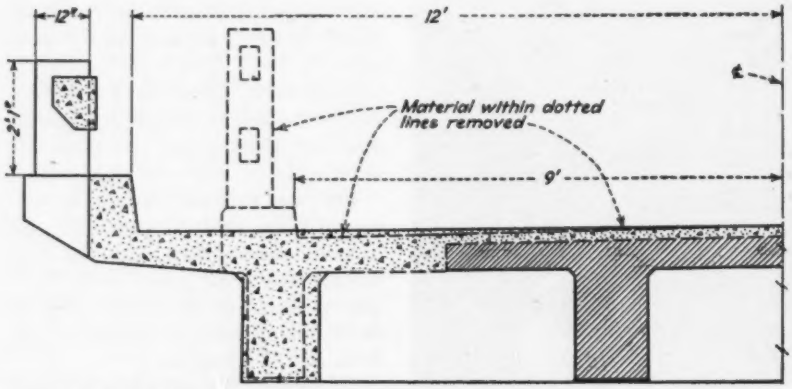
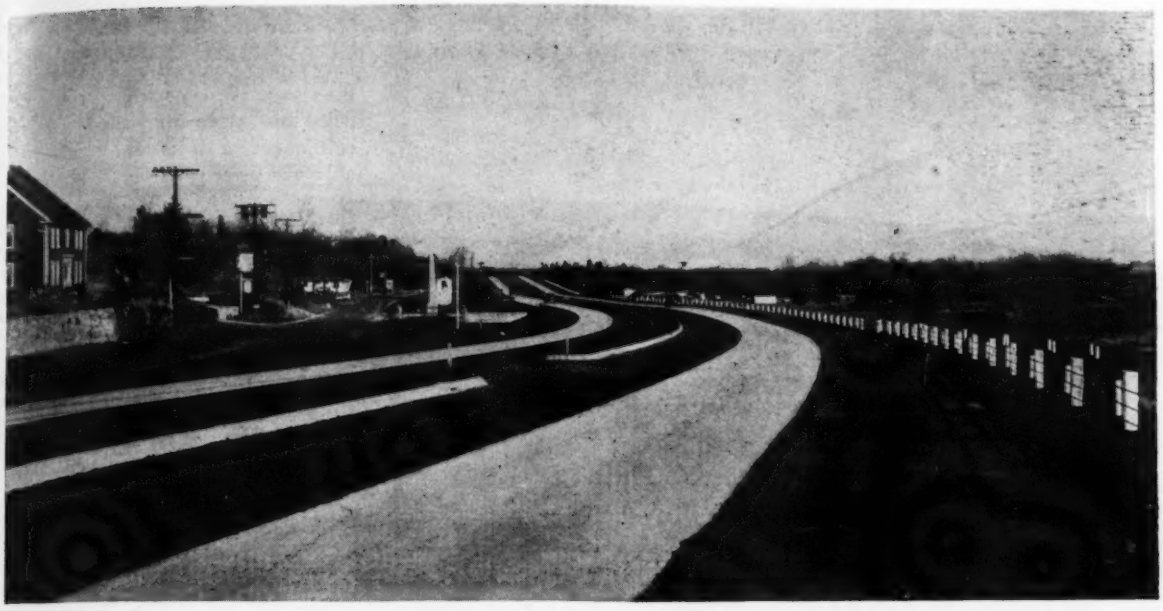


Fig. 6. Section through rebuilt 36-ft. 6-in. span showing outlines of the old and new structures. The part of the old concrete that was retained is shaded.

Attacks on Highway Funds

New attacks on the integrity of highway funds are indicated as a result of the war emergency, according to the National Highway Users Conference. The continuing pressure for diversion in New Jersey and South Carolina may be duplicated in states calling special sessions. Anti-diversion constitutional amendments may be offered in Kentucky, Mississippi, New York and Rhode Island. Such constitutional amendments on the ballot are being circulated in Arkansas and Nebraska. In addition Florida will vote on a constitutional amendment regulating the allocation of highway funds to counties so as to eliminate certain diversions.

Another trend which is not limited to those states having 1942 regular sessions is the mounting pressure for increased sharing of local governmental subdivisions in highway revenues.



Rebuilt Post Road at Charlestown in Rhode Island. Travel lanes are of concrete and passing lanes are of bituminous macadam. Parking lanes have bituminous surfacing.

State Road Work and Programs

***Contents in Brief**—Mileages of major types of highways built in 1941 in each state are given, together with state expenditures for construction, maintenance and equipment. Where estimates for 1942 have been made they also are given. Supplementing these figures are brief statements by the state highway engineers concerning road problems raised by the war and telling how shortages of critical materials are being met.*

A GREAT AMOUNT of uncertainty surrounds the extent and character of the work to be undertaken by the state highway departments in 1942. This is evident in the pages that follow, in which state highway engineers outline the plans of their departments for the year just opening. The work covered is chiefly what the highway department believes should be done to meet urgent needs during the war period or to bring each state's section of the strategic highway network progressively up to standards set by the War Department. Also included is the known or anticipated construction work involved in building access roads to military establishments or to war industries. In evaluating the figures, it should be noted that in most instances they were compiled before war was declared.

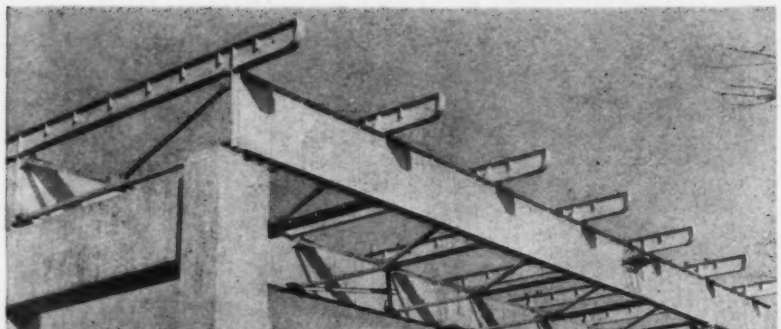
The whole picture is beclouded by the nation's lack of a definite highway policy for the war period. No state yet knows what are the critical war needs within its border. This is due in part to the failure of the federal government to develop a realistic emergency highway policy last year after it became apparent that curtailment of all non-defense activities was an essential part of the nation's defense effort; but it is also due to changes in defense needs since the war with Japan began. That event may call for a great increase in road expenditures in the Pacific States, and it may also make possible complete abandonment of any new work on other sections of the strategic network.

Maintenance expenditures are expected to continue at a slightly accelerated rate, due to curtailment of new construction. This increase raises a critical question with respect to equipment and repair parts due to increasing difficulty in making replacements. Some states report that they are giving special attention to servicing maintenance equipment to prolong its life and keep it in condition for efficient operation for as long as possible.

A few states report that they are giving thought to the effect of possible reductions in funds available for maintenance resulting from curtailment of automobile travel that is expected in view of the tire shortage. No estimates yet have been made as to how much this will cut automobile travel nor as to how much such a cut will reduce highway maintenance.

Post-war road work

At least two states, Minnesota and New York, are planning to carry over some of the work previously planned for 1942 to the post-war period. In Minnesota, the Governor has already transferred to a post-war fund $3,000,000 of current funds that under the state constitution must be



Steel for the new toll bridge over the Thames River at New London, Conn., rises above the housetops to reach the main span which will have a clear height of 173½ ft. over the navigable channel.

spent on roads. The Governor of New York, in his budget message, recommends that most of the $60,000,0000 bond issue authorized last November for expenditures on parkways and main highways, be held over for the post-war period, also that work under the state's grade-crossing elimination program be similarly postponed.

Substitute material

That the highway departments are doing their part in conserving critical material is evident in the statements from state highway engineers that follow. Concrete pavements are being redesigned to eliminate steel reinforcing and steel load-transfer devices at the joints; steel bridges, wherever possible, are being replaced by reinforced concrete or treated timber; small structures that normally are built of reinforced concrete are now being built of mass concrete; and metal culverts are being replaced by treated timber, concrete or tile pipe, or even by the stone boxes of early days of road-building. Old bridges scheduled for replacement are being repaired and strengthened to continue their useful life.

New England States

The State Highway Commission of Maine, according to Lucius D. Barrows, chief engineer, has made no program up to the present time due to the extreme difficulty of making any intelligent estimate of the work that can be undertaken. The estimates given below are based on the state's urgent needs.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	14
Other Dustless Surface	287
Non-Dustless Surface	6
Graded and Drained	....

Expenditures	1941 Actual	1942 Estimated
Construction	$4,768,817	$5,475,000
Maintenance	3,856,685	3,365,000
Equipment	258,629	134,250
Total	8,884,131	8,974,250

Maintenance in New Hampshire

Frederic E. Everett, commissioner of the New Hampshire Highway Department, states that it is highly essential that highway maintenance in that state, which includes snow removal, be maintained at its present standards to prevent deterioration of the system and to provide year-round roads suitable for the movement of trucks and military traffic. The state's income, which is derived wholly from gasoline taxes and motor vehicle registration, will be greatly curtailed, but it is believed that it will be sufficient for these maintenance operations. As to work on the strategic highway network, this will depend on how much money is provided by the federal government.

Critical defense materials are being conserved by the use of wood, mass concrete, stone masonry and vitrified clay pipe. Contractors doing work in the state have experienced some difficulty in replacing and repairing equipment, a situation which probably will grow worse in 1942.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	2
Other Dustless Surface	60
Non-Dustless Surface	14
Graded and Drained	....

Expenditures	1941 Actual	1942 Estimated
Construction	$3,000,000	$2,700,000
Maintenance	2,700,000	2,900,000
Equipment	40,000	40,000
Total	5,740,000	5,640,000

Bridge work needed in Vermont

Vermont has made no estimates of the amount of work to be done in 1942, according to A. J. Runnals, road engineer, but the state expects to carry on the normal amount of maintenance work. The strategic network has some weak and narrow bridges that should be replaced if funds are available, and there are sections of the highway system that are below the military standards for both surfacing and foundations.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	4.9
Other Dustless Surface	78.3
Non-Dustless Surface	....
Graded and Drained	....
Military Road Work in 1941	
Access Roads	12.5

Expenditures	1941 Actual	1942 Estimated
Construction	$1,868,235	.....
Maintenance	1,100,000	.....
Equipment	62,500	.....
Total	3,030,735	.....

Higher maintenance in Massachusetts

Heavy army traffic over the highways of Massachusetts is expected to increase the maintenance expenditures during 1942, according to R. W.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	23
Other Dustless Surface	....
Non-Dustless Surface	....
Graded and Drained	....
Military Road Work in 1941	
Access Roads	13.2

Expenditures	1941 Actual	1942 Estimated
Construction	$4,578,407	$4,630,008
Maintenance	3,303,898	3,432,500
Equipment	135,000	140,000
Total	8,017,305	8,202,508

Coburn, chief engineer of the department of public works. The use of metal is to be eliminated as far as possible in the work planned for construction in 1942.

Standards met in Rhode Island

All roads on the state highway system in Rhode Island are up to or over the minimum military requirements, according to G. H. Henderson, chief highway engineer, hence new construction will be concentrated on needed improvements in the strategic network and on access roads.

No serious shortages in materials have developed. Maintenance equipment is being closely supervised to assure efficient and useful operation.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	14.6
Other Dustless Surface	....
Non-Dustless Surface	....
Graded and Drained	....
Military Road Work in 1941	
Access Roads	1.5

Expenditures	1941 Actual	1942 Estimated
Construction	$1,700,000	$1,800,000
Maintenance	1,265,000	1,270,000
Equipment	135,000	130,000
Total	3,100,000	3,200,000

Civil needs high in Connecticut

William J. Cox, state highway commissioner of Connecticut, states that increases in cost of construction will probably increase expenditures required to bring the strategic network up to standard to about $20,000,000, and, as a considerable mileage of the strategic network which must be rebuilt, should be built to higher standards than those set by the War Department in order to meet civilian needs, the cost will be considerably in excess of $20,000,000.

Construction expenditures were estimated before the rubber situation became acute. Any curtailment of work that must be made as a result of a decline of income from motor vehicle traffic will have to be made in construction expenditures as maintenance must not be curtailed.

A large part of the planned construction expenditures in 1942 are for the Hartford and New London bridge projects and for the Wilbur Cross Parkway. These expenditures are not included in the $20,000,000 above, although the projects are part of the strategic network.

Priorities have been granted for steel required for existing projects. Future work will be so designed as to reduce the use of critical materials, and replacement of steel bridges will be put off where the existing structures can be made to serve a few years more.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	44
Other Dustless Surface	18
Non-Dustless Surface	....
Graded and Drained	7

Expenditures	1941 Actual	1942 Estimated
Construction	$18,833,648	$22,000,000
Maintenance	2,998,000	3,037,000
Equipment	495,000	712,000
Total	22,326,648	25,749,000

Middle Atlantic States

New York's highway budget is now before the state legislature as part of the governor's budget. In November, the voters authorized the expenditure of $60,000,000 of the authorized grade-crossing elimination fund on major highways and parkways, but the governor, in his budget message, recommends an embargo on fresh capital outlay from bond money for roads, parkways and grade crossings, thus building up a fund for use in the post-war period.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	138
Other Dustless Surface	15
Non-Dustless Surface	2
Graded and Drained	17
Military Road Work in 1941	
Access Roads	12

Expenditures	1941 Actual	1942 Estimated
Construction	$17,098,080	.....
Maintenance	8,677,240	.....
Equipment	536,712	.....
Total	26,312,032	.....

Wartime needs high in New Jersey

James Logan, state highway engineer of New Jersey, states that 264 miles of the state highway system needs improvement to accommodate normal traffic, at an estimated cost of $60,000,000. The present indications are that wartime needs will be no less than those in times of peace; bad traffic snarls have already occurred because of the movement of a few minor military units, and there is continuous congestion in the industrial areas on highways that are built to standards considerably in excess of the War Department minimum.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	44.3
Other Dustless Surface	....
Non-Dustless Surface	3.4
Graded and Drained	14.6
Military Road Work in 1941	
Access Roads	2.0

Expenditures	1941 Actual	1942 Estimated
Construction	$9,773,036	$4,500,000
Maintenance	3,597,859	3,700,000
Equipment	200,845	200,000
Total	13,571,740	8,400,000

Pennsylvania to meet war needs

Pennsylvania had planned about $50,000,000 of work for 1942 before the war emergency developed, but now will undertake only such work as

New York State is progressively rebuilding U. S. 9W, the main north-south highway along the west side of the Hudson river.

is dictated by military requirements. The state has had difficulty in getting steel for bridges already under contract; foundations and abutments for many bridges have been completed but steel for the superstructure is lacking.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	2065.6
Other Dustless Surface	55.2
Non-Dustless Surface	40.5
Graded and Drained	8.6

Expenditures	1941 Actual	1942 Estimated
Construction	$49,307,000	Not
Maintenance	17,753,000	available
Equipment	1,000,000*	
Total	68,060,000	

* Unofficial estimate.

Maryland builds access roads

Maryland is engaged in the construction of access highways to military posts and manufacturing plants estimated to cost $14,000,000. Much more of this work is needed, according to Wilson T. Ballard, chief engineer of the state roads commission, but the extent will depend on the amount of federal funds made available. The state also could advantageously spend from seven to ten million dollars on the main arterial system, which, to a large extent, coincides with the strategic network. Between 50 and 60 million dollars is required to bring the whole strategic network up to minimum standards.

The necessity for rapid planning and construction of access roads to the numerous military posts and defense plants in the state has had considerable effect on the state's normal operations.

Designs for work that must be built are being modified to eliminate as far as possible such critical materials as steel, iron, zinc, and aluminum.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	50
Other Dustless Surface	46
Non-Dustless Surface	31
Graded and Drained	....
Military Road Work in 1941	
Access Roads	11.0

Expenditures	1941 Actual	1942 Estimated
Construction	$7,699,463	$12,522,101
Maintenance	3,957,336	4,261,554
Equipment	279,834	415,100
Total	11,936,633	17,198,755

Reductions in Delaware

Plans of the Delaware highway department call for some reduction in construction expenditures in 1942 and considerable reduction in maintenance work. The total cut will be over one and one-quarter million.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	*51
Other Dustless Surface	68
Non-Dustless Surface	42
Graded and Drained	....

Expenditures	1941 Actual	1942 Estimated
Construction	$1,031,148	$1,000,000
Maintenance	2,241,484	986,000
Equipment	97,961	60,000
Total	3,370,593	2,046,000

* Includes 29 miles of concrete widening.

Southern States

Virginia allocated $15,000,000 to primary highway work in 1942 before war was declared. That program was based on normal traffic flow, according to C. S. Mullen, chief engineer of the department of highways. About $8,223,000 of this was for roads outside the strategic network and defense areas that then were considered necessary to keep the highways functioning adequately under normal conditions. These roads, although not classified as defense roads, are a definite necessity to Virginia and indirectly to national defense.

The $15,000,000 allocated to work on the primary highway system in 1942 does not include the $8,000,000 recently appropriated by Congress for construction of access roads in Virginia.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	100.7
Other Dustless Surface	218.0
Non-Dustless Surface	31.0
Graded and Drained	55.1

Expenditures	1941 Actual	1942 Estimated
Construction	$16,128,000	$20,899,000
Maintenance	5,130,000	7,046,000
Equipment	210,000	340,000
Total	21,468,000	28,285,000

Large mileage in West Virginia

West Virginia built 467 miles of dustless surfaced roads in 1941 in addition to 88 miles of paved roads. Expenditures for construction in 1942 are to be cut drastically.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	88
Other Dustless Surface	467
Non-Dustless Surface	25
Graded and Drained	2
Military Road Work in 1941	
Access Roads	2

Expenditures	1941 Actual	1942 Estimated
Construction	$13,975,000	$9,500,000
Maintenance	5,057,000	4,800,000
Equipment	1,100,000	1,200,000
Total	20,132,000	15,500,000

North Carolina cuts program in half

W. Vance Baise, state highway engineer, estimates that construction work in North Carolina done by contract in 1942 will be about half what

As part of the work of making a divided highway out of State Route 29, New Jersey combined a dangerous wye intersection with the Springfield road and a grade crossing with the Westfield-Springfield road into one intersection in which all crossings at grade are eliminated.

Difficult rockwork was involved in reconstructing State Route 219 near Johnstown, Pa., where the new road had to be cut into a sidehill above the main-line tracks of the Pennsylvania Railroad.

was done in 1941. The highway department also expects to be able to secure much less equipment because of priorities. Expenditure of $4,000,000 is needed to take care of access roads to military camps already built, and bringing the strategic network up to minimum requirements will add from $10,000,000 to $12,000,000. Because of difficulty in securing approval from the War Department for both access roads and work on the strategic network, Mr. Baise doubts whether the state will be able to put under contract the $5,000,000 of work that is included in current estimates.

Construction of from one to three more camps is in prospect, which will add more access-road work.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	257
Other Dustless Surface	167
Non-Dustless Surface	1
Graded and Drained	75

Expenditures	1941 Actual	1942 Estimated
Construction	$10,000,000	$5,000,000
Maintenance	11,500,000	12,000,000
Equipment	900,000	550,000
Total	22,400,000	17,550,000

Military road work in South Carolina

Construction in South Carolina in 1942 will be concentrated on needed access roads and other defense projects of the federal government, according to C. R. McMillan, state highway engineer. The amount of this work is expected to be considerable due to the number of training centers being established in that state.

Under a 1941 act of the general assembly, an additional 1,100 miles of roads will be added to the state highway system in 1942. The same number of miles were added in 1941. There is not, however, any provision at law for continuing the extension of the state highway system after 1942.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	22
Other Dustless Surface	174
Non-Dustless Surface	....
Graded and Drained	293
Military Road Work in 1941	
Access Boards	28.8

Expenditures	1941 Actual	1942 Estimated
Construction	$9,500,000	.....
Maintenance	3,283,000	$3,300,000
Equipment	553,000	500,000
Total	13,336,000	3,800,000

Georgia may use temporary bridges

M. L. Shadburn, state highway engineer, states that Georgia is making no estimate of 1942 work due to the war emergency. Non-critical materials are being substituted for critical materials wherever possible on work now under construction, and new designs are being worked out to use a minimum of critical materials. On new grading projects which may be started it is probable that temporary timber bridges will be built to serve until materials for permanent structures can be obtained. Also, a number of bridges which ordinarily would be retired in 1942 will be strengthened with non-critical materials to prolong their life.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	71
Other Dustless Surface	141
Non-Dustless Surface	49
Graded and Drained	78

Expenditures	1941 Actual	1942 Estimated
Construction	$15,604,000	.....
Maintenance	1,422,000	.....
Equipment	.....	.....
Total	17,026,000	.....

Florida expects cut in income

Florida is confining the use of critical materials to a minimum. Tire rationing and curtailed travel is expected to reduce state revenues about $2,500,000, but this will be offset in part by a reallocation of gasoline taxes approved last year which gives the State Road Department four cents of the tax instead of three.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	6
Other Dustless Surface	283
Non-Dustless Surface	20
Graded and Drained	62

Expenditures	1941 Actual	1942 Estimated
Construction	$11,377,131	$21,832,709
Maintenance	3,845,765	5,947,582
Equipment	268,951	130,000
Total	15,491,847	27,910,291

Alabama revises road program

Alabama's program, which normally is made up several years in advance of actual construction, is being revised to suit the war emergency. The original program called for the construction of 150 miles of bituminous paving, carried over from the 1941 work, and the addition of 500 miles in 1942. Also included was additional mileage of gravel and graded-and-drained roads, also the normal bridge-building and grade-separation program. Chris J. Sherlock, state highway director, states that due to the present emergency it is not possible to say what effect the war effort will have on the program, but Alabama needs a large amount of access-road construction to defense bases and defense industries.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	.....
Other Dustless Surface	444.0
Non-Dustless Surface	50.3
Graded and Drained	399.2

Expenditures	1941* Actual	1942 Estimated
Construction	$8,963,510	$14,784,000
Maintenance	2,572,979	2,300,000
Equipment	259,478	400,000
Total	11,795,967	17,484,000

* Figures for fiscal year, ending Sept. 30.

Mississippi's plans are uncertain

Plans for new work in Mississippi, according to R. A. Harris, chief engineer of the state highway department, depend on action taken by the legislature, which now is in session.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	127
Other Dustless Surface	191
Non-Dustless Surface	1
Graded and Drained	128
Military Road Work in 1941	
Access Roads	28

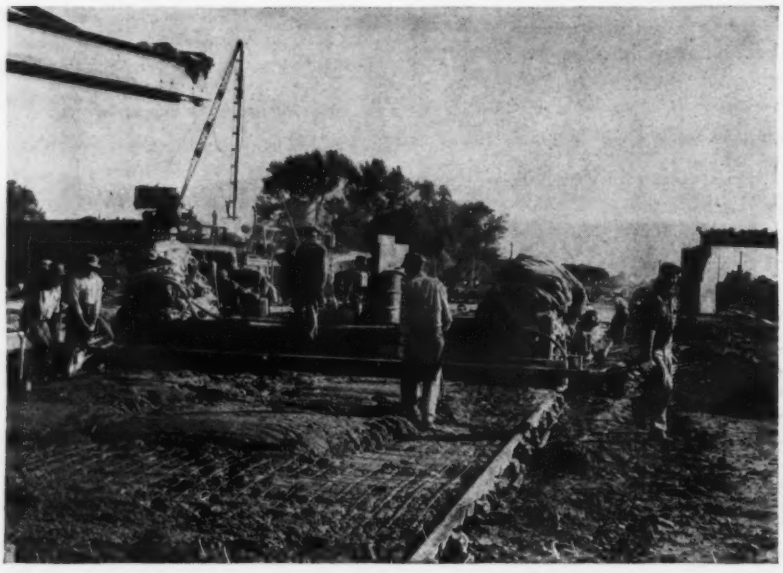
Expenditures	1941 Actual	1942 Estimated
Construction	$6,817,207	.....
Maintenance	1,859,211	.....
Equipment	260,947	.....
Total	8,937,365	.....

Louisiana needs bridges

Harry B. Henderlite, chief engineer of the Louisiana department of highways, states that it will be necessary to replace several hundred bridges on the strategic network which are now substandard as to width or capacity or both in order to meet the standards set by the War Department.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	73
Other Dustless Surface	41
Non-Dustless Surface	120
Graded and Drained	60
Military Road Work in 1941	
Access Roads	24

Expenditures	1941 Actual	1942 Estimated
Construction	$6,500,000	$25,666,700
Maintenance	4,400,000	4,000,000
Equipment	800,000	500,000
Total	11,700,000	30,166,700



A major highway building job in Nebraska in 1941 was construction of the Omaha-Ft. Crook highway, a divided-lane access road.

Also, on at least 75 percent of the strategic network the hard surface is only 18 ft. wide and shoulder width only 5 ft. These shoulders should be widened to 10 ft. and surfaced with some type of gravel or shell.

Kentucky follows 1941 plan

More than half of the 1941 construction funds in Kentucky were placed on the strategic network, according to T. H. Cutler, chief engineer of the department of highways. This will be true of 1942. After 1942, about $11,000,000 will be needed to place the strategic network in proper condition. State standards are being revised to eliminate or reduce strategic materials to the smallest amount.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	225
Other Dustless Surface	269
Non-Dustless Surface	83
Graded and Drained	45
Military Road Work in 1941	
Access Roads	16.5

Expenditures	1941 Actual	1942 Estimated
Construction	$14,550,000	$11,823,300
Maintenance	5,275,000	6,500,000
Equipment	543,000	500,000
Total	20,368,000	18,823,300

Tennessee cuts budget

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	41.2
Other Dustless Surface	104.7
Non-Dustless Surface	47.7
Graded and Drained	110.2

Expenditures	1941 Actual	1942 Estimated
Construction	$7,665,068	$6,355,000
Maintenance	1,519,691	1,800,000
Equipment	1,693,038	1,600,000
Total	10,877,797	9,755,000

Middle Western States

Indiana, according to M. R. Keefe, expects to concentrate on the construction of access roads to industrial plants engaged in defense work and to army and naval bases to provide sufficient facilities to handle the increased traffic to these plants. This will include adding dual lanes to important highways leading out of Indianapolis and to some ordnance plants.

Indiana is redesigning all rigid-type pavements to eliminate mesh reinforcing, re-spacing the contraction joints, and eliminating load-transfer devices in order to conserve critical materials. All small structures that normally would be built of reinforced concrete are being redesigned to use mass-concrete arches. It is possible that all structures with spans above 20 ft. will be redesigned to use timber construction as a temporary expedient, the structures to be replaced after the war with reinforced concrete.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	680
Other Dustless Surface	562
Non-Dustless Surface	30
Graded and Drained	102
Military Road Work in 1941	
Access Roads	18.8

Expenditures	1941 Actual	1942 Estimated
Construction	$19,780,000	$19,300,000
Maintenance	4,500,000	4,500,000
Equipment	278,000	200,000
Total	24,558,000	24,000,000

Much access road work in Ohio

Access road construction at various points in Ohio will call for about $7,000,000, according to G. R. Logue, chief engineer of the department of highways. The state's program of work on the strategic network calls for widening, resurfacing, shoulder stabilization, and bridge repair and widening work on 1,381 miles at an estimated cost of $33,000,000.

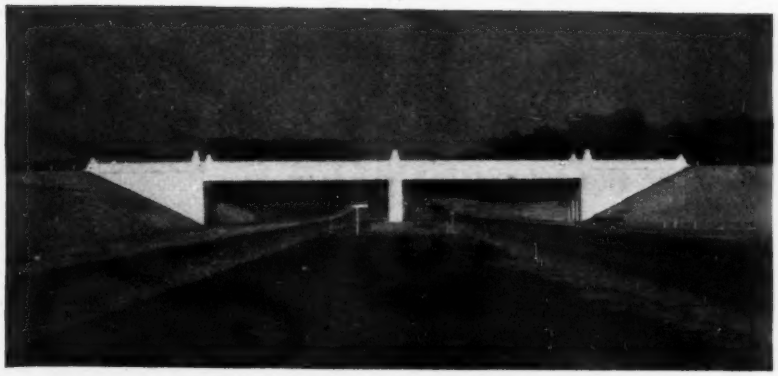
Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	377.9
Other Dustless Surface	2,414.9
Non-Dustless Surface	172.0
Graded and Drained	.....
Military Road Work in 1941	
Access Roads	6.6

Expenditures	1941 Actual	1942 Estimated
Construction	$21,916,552	$28,348,393
Maintenance	14,340,483	15,110,200
Equipment	713,000	600,000
Total	36,970,035	44,058,593

Pavements needed in Illinois

Illinois needs to reconstruct 250 miles of pavement, much of which is on the strategic work, and a like amount of bituminous surfacing needs attention to prolong its life during the war period. About 75 miles of access roads to camps and war industries also must be built.

A concrete pavement design has been developed for the war period that has a uniform thickness and omits all reinforcing steel, longitudinal metal points and tie-bars, and load-transfer devices at expansion joints.



Middle River grade separation to carry the access road to the Glenn L. Martin Aircraft plant over the Philadelphia Road in Baltimore County, Md.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	171
Other Dustless Surface	95
Non-Dustless Surface	113
Graded and Drained	66

Expenditures	1941 Actual	1942 Estimated
Construction	$18,500,000	Not
Maintenance	6,400,000	available
Equipment	850,000	.....
Total	25,750,000	.....

Wisconsin defers much work

E. L. Roettiger, state highway engineer of Wisconsin, states that the extent and nature of highway work necessary in 1942 to keep the state's system up to efficiency to meet the nation's war needs is so relative that a specific and detailed statement of plans is impossible. Many improvements in the long-range plan will have to be deferred, Palliative improvements and intensive maintenance, for a limited time, can meet the immediate needs for current traffic, and it may be found that such work may be adequate if civilian travel is reduced by restrictions imposed on motor vehicles, tires, and possibly fuel.

The department is prepared to construct pavements in which all steel is eliminated and to substitute plain masonry or timber for steel and reinforced concrete in minor structures. Work on certain large structures may possibly be deferred entirely.

Road use rises in Michigan

Michigan needs $20,000,000 of new construction to correct deficiencies in the strategic network, and in addition requires $31,361,000 for roads to military reservations and industrial production areas, particularly in and near the city of Detroit, according to H. C. Coons, deputy commissioner and chief engineer of the highway department. The 1943 federal-aid allocations, in addition to unencumbered balances from prior fiscal years, will be used exclusively for work on the strategic network. This will be about $5,000,000. The amount of access road construction will be determined by certification of the War Department.

Shortages of critical materials are being met principally through

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	79
Other Dustless Surface	190
Non-Dustless Surface	86
Graded and Drained	80
Military Road Work in 1941	
Access Roads	4

Expenditures	1941 Actual	1942 Estimated
Construction	$10,000,000	$10,000,000
Maintenance	5,215,000	5,800,000
Equipment	.....	.....
Total	15,215,000	15,800,000

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	88
Other Dustless Surface	160
Non-Dustless Surface	67
Graded and Drained	10
Military Road Work in 1941	
Access Roads	18

Expenditures	1941 Actual	1942 Estimated
Construction	$15,785,479	.....
Maintenance	6,892,000	$8,000,000
Equipment	250,000	250,000
Total	22,927,479	.....

changes in design. Substitute materials are being used to a considerable extent on bridges and grade separations.

West of the Mississippi

Minnesota to meet acute needs

Highway construction in Minnesota will be based on meeting acute necessity, according to M. J. Hoffman, commissioner of highways, and work previously programed will be deferred. This is in line with a program, recently announced by Governor Stassen, of placing funds constitutionally dedicated to highway purposes in a post-war highway fund so that deferred projects may be gotten underway without delay when the war emergency is passed. The sum of $3,000,000, which under normal conditions would have been placed under contract early in the year, has already been earmarked for the post-war reserve fund. The ultimate size of the fund will depend primarily upon the demand for defense construction and the increased maintenance load, which must be met out of the state's income as reduced by the curtailed motor traffic.

Construction estimates for 1942 show only the carryover from 1941.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	109
Other Dustless Surface	278
Non-Dustless Surface	127
Graded and Drained	440

Expenditures	1941 Actual	1942 Estimated
Construction	$15,392,000	$3,992,000
Maintenance	7,993,000	7,280,000
Equipment	.....	.....
Total	23,385,000	11,272,000

Missouri cuts road program

Since the estimates given in the accompanying table were made, the Missouri State Highway Commission has instructed C. W. Brown, chief engineer, to work out a plan of reduced operations "commensurate with the present critical situation." Expenditures in 1941 were chiefly on modernization of the state highway system, including a considerable amount of mileage in the strategic network, and on the extension of farm-to-market roads.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	210.7
Other Dustless Surface	568.0
Non-Dustless Surface	205.7
Graded and Drained	45.8

Expenditures	1941 Actual	1942 Estimated
Construction	$12,589,000	$13,500,000
Maintenance	6,500,000	6,500,000
Equipment	.....	.....
Total	19,089,000	20,000,000

Equipment scarce in Arkansas

The Arkansas highway department, according to W. W. Mitchell, director, has experienced some difficulty in getting new equipment for maintenance work.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	6
Other Dustless Surface	101
Non-Dustless Surface	32
Graded and Drained	25

Expenditures	1941 Actual	1942 Estimated
Construction	$3,438,000	.....
Maintenance	1,179,000	$1,300,000
Equipment	224,000	300,000
Total	4,841,000	1,600,000

Maintenance high in North Dakota

Maintenance expenditures in North Dakota are expected to be somewhat higher in 1942 than in 1941, and it is hoped that the state will be able to reconstruct the most critically deficient sections of the strategic network. These deficiencies, it is believed, should be corrected before shortage in manpower puts a check on continued highway construction.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	97
Other Dustless Surface	80
Non-Dustless Surface	....
Graded and Drained	....

Expenditures	1941 Actual	1942 Estimated
Construction	$4,159,746	$4,800,000
Maintenance	1,758,995	2,100,000
Equipment	148,000	.....
Total	6,066,741	6,900,000

Nebraska waits approval of plans

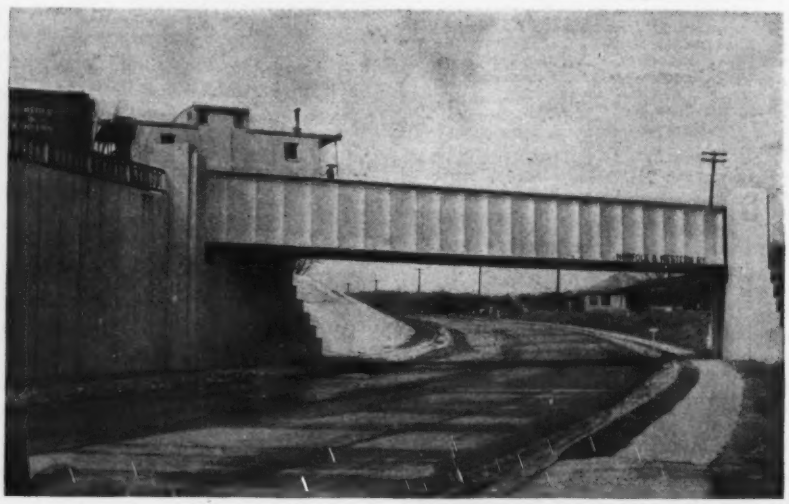
The 1942 program prepared by the state highway department is designed to keep the highway system up to the efficiency called for in meeting the nation's war needs, according to Wardner G. Scott, state highway engineer, but whether it will be carried out depends on whether it is approved by the proper federal authorities.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	19
Other Dustless Surface	269
Non-Dustless Surface	189
Graded and Drained	....
Military Road Work in 1941	
Access Roads	8

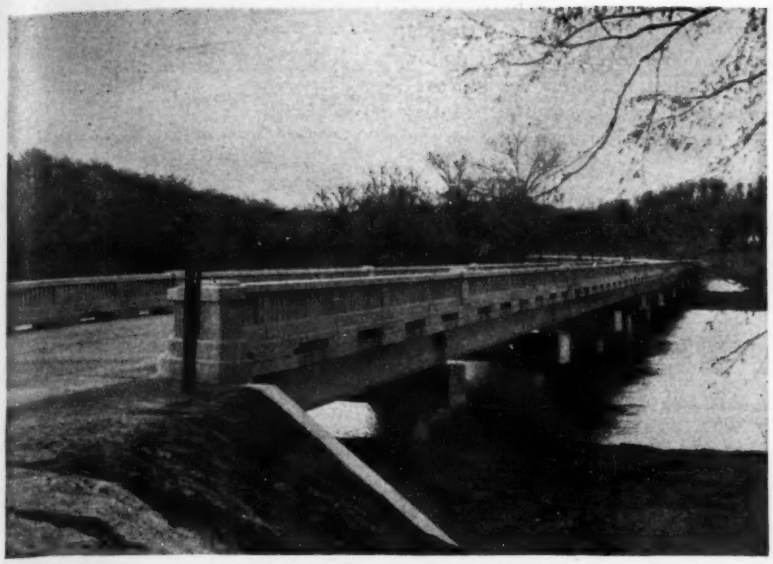
Expenditures	1941 Actual	1942 Estimated
Construction	$6,322,900	$8,000,000
Maintenance	3,200,000	3,000,000
Equipment	.....	.....
Total	9,522,900	11,000,000

The department plans to construct about 130 miles of bituminous surfacing and about 50 miles of concrete pavement, but that work waits federal approval.

Nebraska is redesigning its small box culverts to use plain concrete instead of reinforced concrete, is adopting designs for bridges that reduce the amount of critical materials, and



Ohio State Route 74 was put under the Norfolk & Western R. R. tracks at Batavia by raising the tracks and station 5 ft. and cutting down the highway grade.



New crossing of the Elk River on U. S. Route 71 in McDonald County, in southwestern Missouri.

is simplifying its standard specifications to reduce the number of sizes and shapes of critical materials that are required. It also is using revised unit working stresses issued by the Public Roads Administration in its memorandum of Dec. 9, 1941.

Defense need low in South Dakota

E. W. Meeker, state highway engineer of South Dakota, states that the commission's highway program is based on progressively bringing the strategic network up to minimum standards, but that it is impossible to state how much work will be undertaken due to the fact that the state has no defense industries. If there are to be troop movements through the state, the department is prepared to do whatever work is necessary for that purpose.

The department is making studies to replace its common I-beam-type bridge with reinforced concrete, and it may be that treated timber will be substituted in some places. The department has eliminated the construction of guard rails using critical materials and has salvaged a great amount of old guard-rail cable and fittings for use on new work requiring guard rails.

Resurfacing needed in Kansas

Kansas has a considerable mileage of the strategic network on which the surface is inadequate, according to R. C. Keeling, state highway engineer. Many bridges also are inadequate for military loads. The road surfaces range from light-type oil penetration to heavy types of surfacing, which have become practically worn out, reaching a hazardous stage. There are numerous locations where high water stops traffic, there is lack of adequate access highways to serve defense industries, and a lack of adequate bypass roads around one army post.

The state has discontinued the use of structural steel for bridges wherever possible, having done this since early in 1941, and now is eliminating reinforcing steel from small structures as far as possible, using plain concrete. Plain concrete also is being used in pavements in place of reinforced concrete.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	8.0
Other Dustless Surface	221.7
Non-Dustless Surface	109.3
Graded and Drained	260.6

Expenditures	1941 Actual	1942 Estimated
Construction	$3,800,000	$4,000,000
Maintenance	2,200,000	2,200,000
Equipment	120,000	120,000
Total	6,120,000	6,320,000

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	24
Other Dustless Surface	517
Non-Dustless Surface	233
Graded and Drained	280

Expenditures	1941 Actual	1942 Estimated
Construction	$8,772,834	$8,121,026
Maintenance	3,124,819	3,225,089
Equipment	1,191,217	1,147,341
Total	13,088,870	12,493,456

Texas to adjust road plans

Due to rapidly changing conditions, R. L. Schmidt, assistant to the state highway engineer of Texas, states that the department's plans, which were based on needs as anticipated before the war emergency, will be adjusted to meet emergency needs as they develop.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	391
Other Dustless Surface	1,276
Non-Dustless Surface	197
Graded and Drained	161

Expenditures	1941 Actual	1942 Estimated
Construction	$23,384,491	$25,000,000
Maintenance	8,702,392	9,000,000
Equipment	653,113	700,000
Total	32,739,996	34,700,000

Oklahoma stresses maintenance

Oklahoma is endeavoring as far as possible to maintain its highways in an efficient condition, with emphasis on military roads. The state has access-road work programmed that will cost over $2,200,000.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	214
Other Dustless Surface	75
Non-Dustless Surface	290
Graded and Drained	40

Expenditures	1941 Actual	1942 Estimated
Construction	$8,101,000*	$8,750,000
Maintenance	3,455,000*	3,750,000
Equipment	.....	400,000
Total	11,556,000	12,900,000

*Includes equipment.

Montana to stop work on feeder roads

Montana's feeder-road program is to be suspended until after the war emergency, according to a recent statement by the chairman of the state highway commission. He added that as Montana is not in the immediate defense area, the amount of work on the main highway system that will be permitted by the federal government has yet to be determined.

The above statement was made

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	0.8
Other Dustless Surface	177
Non-Dustless Surface	127
Graded and Drained	36

Expenditures	1941 Actual	1942 Estimated
Construction	$5,470,000	$6,000,000
Maintenance	2,100,000	3,370,000
Equipment	160,000	.....
Total	7,730,000	9,370,000

after the figures given in the accompanying tabulation were prepared by Howard Holmes, state highway engineer.

Wyoming keeps up main roads

Frank Kelso, superintendent, Wyoming highway department, states that the 1942 program has been cut to the absolute minimum needs to keep the highway system functioning. The system can take considerably more traffic without failure, but on account of not being able to reconstruct several hundred miles of road needing reconstruction, it will be necessary to carry on considerable betterment work in the way of widening and providing additional base course.

The department intends to keep its sections of the transcontinental highways in first-class condition so that they can take the load that may be thrown upon them.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	....
Other Dustless Surface	525
Non-Dustless Surface	245
Graded and Drained	185

Expenditures	1941 Actual	1942 Estimated
Construction	$4,300,000	$1,000,000
Maintenance	830,000	1,000,000
Equipment	622,538	200,000
Total	5,752,538	2,200,000

Minimum needs for Colorado

The Colorado highway department hopes to have $5,500,000 for construction and oiling of highways in 1942. W. M. Williams, director of publicity, states that this amount does not by any means represent the minimum needs of the highway department for 1942. It represents only the funds that probably will be available and they may be cut. On Colorado's strategic highways, totaling 1,175 miles, there are 65 miles of entirely new highways that must be built to make the system available for use. In addition, numerous improvements are needed on military routes, and inadequate bridges need to be replaced.

Colorado expects to spend more on maintenance this year in order to keep highways not on the military system in condition for use.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	1
Other Dustless Surface	317
Non-Dustless Surface	156
Graded and Drained	16
Military Road Work in 1941	
Access Roads	76.5

Expenditures	1941 Actual	1942 Estimated
Construction	$5,343,000	$5,500,000
Maintenance	1,373,000	1,500,000
Equipment	244,000	250,000
Total	6,960,000	7,250,000

New Mexico's plans to be cut

New Mexico's present highway construction program was prepared before the war emergency, hence it is expected that major changes will be made in the work previously planned for 1942.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	26
Other Dustless Surface	60
Non-Dustless Surface	234
Graded and Drained	113

Expenditures	1941 Actual	1942 Estimated
Construction	$6,750,000*	$9,971,673
Maintenance, Equipment	1,750,000*	2,398,185 300,000
Total	8,500,000	12,669,858

* Unofficial estimate.

Far West States

Idaho's 1942 program is designed to eliminate projects requiring strategic material, according to S. E. Johnson, director of highways. The highway department anticipates that it will be unable to secure sufficient maintenance equipment.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	10
Other Dustless Surface	463
Non-Dustless Surface	562
Graded and Drained	529
Military Road Work in 1941	
Access Roads	8.5

Expenditures	1941 Actual	1942 Estimated
Construction	$5,000,000	$3,000,000
Maintenance	1,500,000	1,200,000
Equipment	300,000	100,000
Total	6,800,000	4,300,000

Arizona work may increase

F. N. Grant, deputy state engineer, reports that there is a prospect that Arizona will receive an additional $4,150,000 of emergency federal-aid funds, bringing the total construction for 1942 to $8,415,000. Arizona has changed 138 bridges from steel to concrete to meet the lack of steel.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	5.7
Other Dustless Surface	141.6
Non-Dustless Surface	13.4
Graded and Drained	11.0

Expenditures	1941 Actual	1942 Estimated
Construction	$4,288,591	$4,265,000
Maintenance	1,402,478	1,600,000
Equipment	295,573	200,000
Total	5,986,642	6,065,000

Mostly maintenance in Nevada

The Nevada income for highway purposes is not sufficient to warrant state-financed construction, according to Robert A. Allen, state highway engineer, hence it must be reserved for maintenance and for matching federal funds.

During 1941, timber bridges were used in place of reinforced concrete to conserve reinforcing steel, and corrugated culvert pipes were used wherever possible for the same purpose. During 1941, concrete or clay pipe will be used.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	....
Other Dustless Surface	156
Non-Dustless Surface	11
Graded and Drained	....
Military Road Work in 1941	
Access Roads	32

Expenditures	1941 Actual	1942 Estimated
Construction	$3,001,202	$2,752,000
Maintenance	774,574	900,000
Equipment	314,188	100,000
Total	4,089,964	3,752,000

Only urgent work in Washington

The Washington state highway construction program for 1942, according to Burwell Bantz, director of highways, will be confined to projects which are on a few important routes of the strategic network, and which are considered most urgently needed to insure maintenance of satisfactory service. These consist principally of new construction where congested traffic conditions exist,

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	8
Other Dustless Surface	397
Non-Dustless Surface	97
Graded and Drained	....

Expenditures	1941 Actual	1942 Estimated
Construction	$7,000,000	$7,560,000
Maintenance	3,800,000	3,820,000
Equipment	.....	.....
Total	10,800,000	11,380,000

Separation of grades at an important intersection of the new highway between Seattle and Issaquah, Washington.

reconstruction of weak bridges, and reinforcing existing surfaces which have shown evidence of distress under the increased loads imposed by military and industrial traffic. The needs along this line are greatly in excess of funds which can be made available.

Substitution of materials not on the critical material list is being made wherever possible. In many instances temporary construction with non-critical materials will be necessary.

The problem with respect to equipment appears most difficult, though inventories are adequate at present. As equipment becomes worn and repair parts are exhausted, the problem will become acute.

Oregon to increase maintenance

Curtailment of construction and betterment work in Oregon will necessitate increased maintenance expenditures in order to keep the highway system adequate to carry defense goods and army transports. Elimination of critical deficiencies in the strategic network will cost $8,000,000, and building access roads to military reservations and defense industries will add another $2,000,000.

Oregon already has put into effect drastic curbs on the use of the department's motorized equipment, and is giving increased care to its maintenance equipment in order that it may fully meet the requirements of heavy traffic generated by war needs.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	32
Other Dustless Surface	295
Non-Dustless Surface	312
Graded and Drained	266

Expenditures	1941 Actual	1942 Estimated
Construction	$8,286,000	$8,000,000
Maintenance	4,056,000	5,100,000
Equipment	525,000	350,000
Total	12,867,000	13,450,000

California to speed work

With California having been declared an area of military operations, C. H. Purcell, state highway engineer, holds that it is most imperative that needed works on the strategic network be accomplished at the earliest possible moment if the military forces are to move men and heavy equipment over roads and bridges of the network. The state had $32,000,000 programmed for 1942, but how much of this work can be done is a matter of conjecture.

California has a large access-road problem due to the many military establishments and great defense industries. It is estimated that $45,000,000 is needed for the purchase of right-of-way and construction of these projects. The department has surveys made and plans ready for advertising for bids on $18,000,000 of this work as soon as federal funds and the right-of-way can be secured.

The state plans to use timber bridges to replace steel structures wherever possible, mass concrete in lieu of reinforced concrete, and other materials to replace metal culverts. In several instances, the department has already changed bridge designs to eliminate critical materials and it is expected that this practice will become more and more prevalent.

Curtailment of automobile travel is expected to reduce highway revenues drastically during 1942.

Mileage Built	1941
Pavement (concrete, brick, asphalt, bituminous concrete and bituminous penetration)	39.2
Other Dustless Surface	303.1
Non-Dustless Surface	....
Graded and Drained	20.4
Military Road Work in 1941	
Access Roads	20.5

Expenditures	1941 Actual	1942 Estimated
Construction	$27,883,500	$31,060,000
Maintenance	12,332,100	9,909,000
Equipment	1,216,000	1,000,000
Total	41,431,600	41,969,000

Roadbuilding in 1941—Money and Miles

***Contents in Brief**—State highway departments in 46 states reported expenditures of $701,547,000 in 1941, a gain of 4 percent over 1940. Construction, 68 percent of the total, was up 6 percent; and maintenance and equipment, 32 percent, rose 0.3 percent. Mileage constructed by 46 states reached 27,046 miles, substantially below 1940, but 22 percent was of high-type pavement construction as compared with 12 percent in this category a year ago. Budgets from 37 states for 1942 indicate a 12 percent rise in new construction, and a 7 percent gain in maintenance and equipment spending.*

STATE HIGHWAY expenditure for construction, maintenance and equipment during 1941, reported by 46 of the 48 state highway departments, totaled $701,547,000, a 4 percent increase over the $673,559,000 for the same states in 1940. The forecast of 1941 state highway volume made in January of that year, and based on budgets from 45 states, indicated that 1941 would climb less than 1 percent over the preceding year (*ENR* Jan. 16, 1941, p. 100). This was due principally to the fact that although considerable work on access roads and on the strategic network was anticipated, it also was expected that increasing defense activities would force curtailment of normal road work in 1942. Actually, much of the anticipated access-road work did not materialize, but that in turn was offset by more work on main highways. The result is remarkable when the uncertainties that surrounded highway financing during the year are considered.

Of the 1941 expenditures, $487,371,000 was for new highway construction, 68 percent of the total; and $214,176,000 was for maintenance and equipment, 32 percent of the volume.

Geographically, the southern states led the nation in highway spending. This region was responsible for $173,533,000, or 25 percent of the total state highway expenditures for construction, maintenance and equipment; West of Mississippi (Iowa missing), accounted for $146,268,000, or 21 percent; Middle West, $125,420,000, or 18 percent; Middle Atlantic, $123,251,000, or 17 percent; Far West (Utah missing), $81,976,000, or 12 percent; and New England, $51,099,000, or 7 percent.

New construction's portion of the total highway expenditures, $487,371,000, was up 6 percent over 1940, and was distributed sectionally as follows: 25 percent in the South; 22 percent in the West of Mississippi states; 18 percent in Middle West states; 17 percent in Middle Atlantic; 11 percent in the Far West, and 7 percent in New England.

Maintenance and equipment expenditures reached $214,176,000 for the past year, an increase of less than 1 percent over the 46-state 1940 total. Almost $52,500,000 of this volume was spent in the South; $41,076,000 in the West of Mississippi; $39,438,000 in the Middle West; $38,343,000

HIGHWAY CONSTRUCTION RECORDS FOR 46 STATES

States	Mileage Completed — 1941					Expenditures — 1941 (,000 omitted)			Expenditure Budget — 1942 (,000 omitted)		
	Total	Pavement	Dustless	Non-Dustless	Graded & Drained	Total Const. & Maint.	Con. struction	Maint. & Equipment	Total Const. & Maint.	Con. struction	Maint. & Equipment
Me.	307.0	14.0	287.0	6.0	.....	$8,884	$4,769	$4,115	$8,974	$5,475	$3,499
N. H.	76.0	2.0	60.0	14.0	.....	5,740	3,000	2,740	5,640	2,700	2,940
Vt.	83.2	4.9	78.3	.....	.....	3,031	1,868	1,163	.....	.....	.....
Mass.	23.0	23.0	.....	.....	.....	8,017	4,578	3,439	8,203	4,630	3,573
R. I.	14.6	14.6	.....	.....	.....	3,100	1,700	1,400	3,200	1,800	1,400
Conn.	69.0	44.0	18.0	.....	7.0	22,327	18,834	3,493	25,749	22,000	3,749
New Eng.	**572.8**	**102.5**	**443.3**	**20.0**	**7.0**	**$51,099**	**$34,749**	**$16,350**	**$51,766**	**$36,605**	**$15,161**
N. Y.	172.0	138.0	15.0	2.0	17.0	$26,312	$17,098	$9,214	.....	.....	.....
N. J.	62.2	44.2[1]	.....	3.4	14.6	13,572	9,773	3,799	8,400	4,500	3,900
Pa.	2,169.9	2,065.6	55.2	40.5	8.6	68,060	49,307	18,753	.....	.....	.....
Md.	127.0	50.0	46.0	31.0	.....	11,936	7,699	4,237	17,199	12,522	4,677
Del.	161.0	51.0[2]	68.0	42.0	.....	3,371	1,031	2,340	2,046	1,000	1,046
Mid. Atl.	**2,692.1**	**2,348.8**	**184.2**	**118.9**	**40.2**	**$123,251**	**$84,908**	**$38,343**	**$27,645**	**$18,022**	**$9,623**
Va.	404.7	100.7[3]	218.0[3]	30.9	55.1	$21,468	$16,128	$5,340	$28,285	$20,899	$7,386
W. Va.	582.0	88.0	467.0	25.0	2.0	20,132	13,975	6,157	15,500	9,500	6,000
N. C.	500.0	257.0	167.0	1.0	75.0	22,400	10,000	12,400	17,550	5,000	12,550
S. C.	489.0	22.0	174.0	.....	293.0	13,336	9,500	3,836	3,800[3]	.....	3,800
Ga.	339.0	71.0	141.0	49.0	78.0	17,026	15,604	1,422	.....	.....	.....
Fla.	371.0	6.0	283.0	20.0	62.0	15,492	11,377	4,115	27,910	21,833	6,077
Ala.[4]	893.5	.....	444.0	50.3	399.2	11,796	8,964	2,832	17,484	14,784	2,700
Miss.	447.0	127.0	191.0	1.0	128.0	8,937	6,817	2,120	.....	.....	.....
La.	294.0	73.0	41.0	120.0	60.0	11,700	6,500	5,200	30,167	25,667	4,500
Ky.	622.0	225.0	269.0	83.0	45.0	20,368	14,550	5,818	18,823	11,823	7,000
Tenn.	303.8	41.2	104.7	47.7	110.2	10,878	7,665	3,213	9,755	6,355	3,400
South.	**5,246.0**	**1,010.9**	**2,499.7**	**427.9**	**1,307.5**	**$173,533**	**$121,080**	**$52,453**	**$169,274**	**$115,861**	**$53,413**
Ohio	2,964.8	377.9	2,414.9	172.0	.....	$36,970	$21,917	$15,053	$44,059	$28,349	$15,710
Ind.	1,374.0[5]	680.0[5]	562.0[5]	30.0[5]	102.0[5]	24,558	19,780	4,778	24,000	19,300	4,700
Ill.	445.0	171.0	95.0	113.0	66.0	25,750	18,500	7,250	.....	.....	.....
Wis.	435.0	79.0	190.0	86.0	80.0	15,215	10,000	5,215	15,800	10,000	5,800
Mich.	325.0	88.0	160.0	67.0	10.0	22,927	15,785	7,142	8,250[3]	.....	8,250
Mid. West.	**5,543.8**	**1,395.9**	**3,421.9**	**468.0**	**258.0**	**$125,420**	**$85,982**	**$39,438**	**$92,109**	**$57,649**	**$34,460**
Minn.	954.0	109.0	278.0	127.0	440.0	$13,900	$12,760	$1,140	$11,272[3]	$3,992[3]	$7,280
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mo.	1,030.2	210.7	568.0	205.7	45.8	19,089	12,589	6,500	20,000	13,500	6,500
Ark.	164.0	6.0	101.0	32.0	25.0	4,841	3,438	1,403	1,600[3]	.....	1,600
N. D.	177.0	97.0	80.0	.....	.....	6,067	4,160	1,907	6,900	4,800	2,100
S. D.	599.6	8.0	221.7	109.3	260.6	6,120	3,800	2,320	6,320	4,000	2,320
Neb.	477.0	19.0	269.0	189.0	.....	9,523	6,323	3,200	11,000	8,000	3,000
Kan.	1,084.0	24.0	517.0	233.0	280.0	13,089	8,773	4,316	12,493	8,121	4,372
Okla.	619.0	214.0	75.0	290.0	40.0	11,956	8,101	3,855	13,300	8,900	4,400
Tex.	2,025.0	391.0	1,276.0	197.0	161.0	32,740	23,385	9,355	34,700	25,000	9,700
Mont.	340.8	0.8	177.0	127.0	36.0	7,730	5,470	2,260	9,370	6,000	3,370
Wyo.	955.0	.....	525.0	245.0	185.0	5,753	4,300	1,453	2,200	1,000	1,200
Colo.	490.0	1.0	317.0	156.0	16.0	6,960	5,343	1,617	7,250	5,500	1,750
N. M.	433.0	26.0	60.0	234.0	113.0	8,500	6,750[7]	1,750[7]	12,670	9,972	2,698
W. of Miss.	**9,318.6**	**1,106.5**	**4,464.7**	**2,145.9**	**1,602.4**	**$146,268**	**$105,192**	**$41,076**	**$149,075**	**$98,785**	**$50,290**
Idaho	1,564.0	10.0	463.0	562.0	529.0	$6,800	$5,000	$1,800	$4,300	$3,000	$1,300
Utah	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ariz.	171.7	5.7	141.0	13.4	11.0	5,987	4,289	1,698	6,065	4,265	1,800
Nev.	167.0	.....	156.0	11.0	.....	4,090	3,001	1,089	3,752	2,752	1,000
Wash.	502.0	8.0	397.0	97.0	.....	10,800	7,000	3,800	11,380	7,560	3,820
Ore.	905.0	32.0	295.0	312.0	266.0	12,867	8,286	4,581	13,450	8,000	5,450
Calif.	362.7	39.2	308.1	.....	20.4	41,432	27,884[8]	13,548	41,969	31,060[3]	10,909
Far West.	**3,672.4**	**94.9**	**1,755.7**	**995.4**	**826.4**	**$81,976**	**$55,460**	**$26,516**	**$80,916**	**$56,637**	**$24,279**
U. S.	**27,045.7**	**6,059.5**	**12,769.5**	**4,175.2**	**4,041.5**	**$701,547**	**$487,371**	**$214,176**	**$570,785**	**$383,559**	**$187,286**

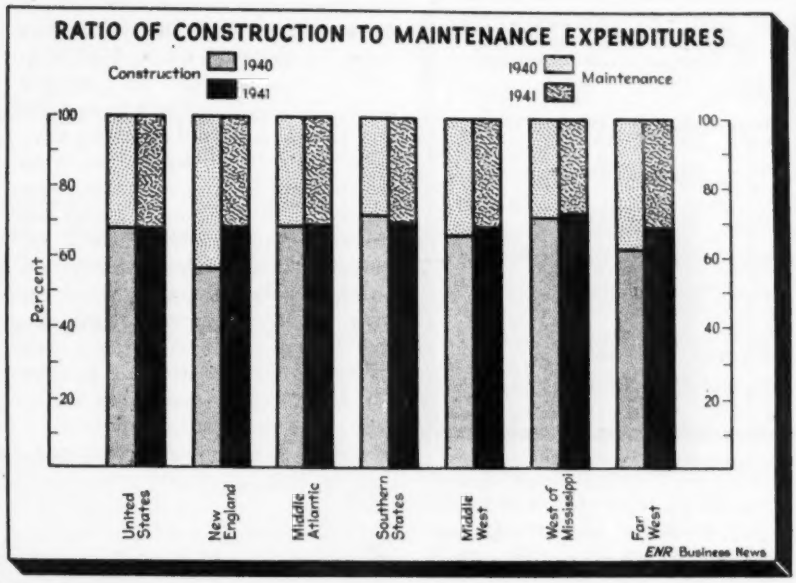
[1] Includes widening and dualization. [2] Includes widening. [3] Maintenance and equipment only. [4] Fiscal year ending Sept. 30. [5] In progress to June 30, 1941. [6] Carryover from 1941 program. [7] Unofficial estimate. [8] Includes right-of-way; engineering; and state route work in cities.

in Middle Atlantic; $26,516,000 in the Far West; and $16,350,000 in New England.

Construction continued to take just a little more than two-thirds of the state highway funds for the nation as a whole, accounting for 68 percent of the volume. Maintenance and equipment spending took the other 32 percent. New England and Middle Western states matched this national construction-maintenance ratio exactly, while Middle Atlantic reported construction at 69 percent and maintenance at 31 percent. West of Mississippi, however, spent 72 percent of its funds for construction, and the balance, 28 percent, for maintenance and equipment. The South spent on a 70-30 ratio, the larger share being for construction.

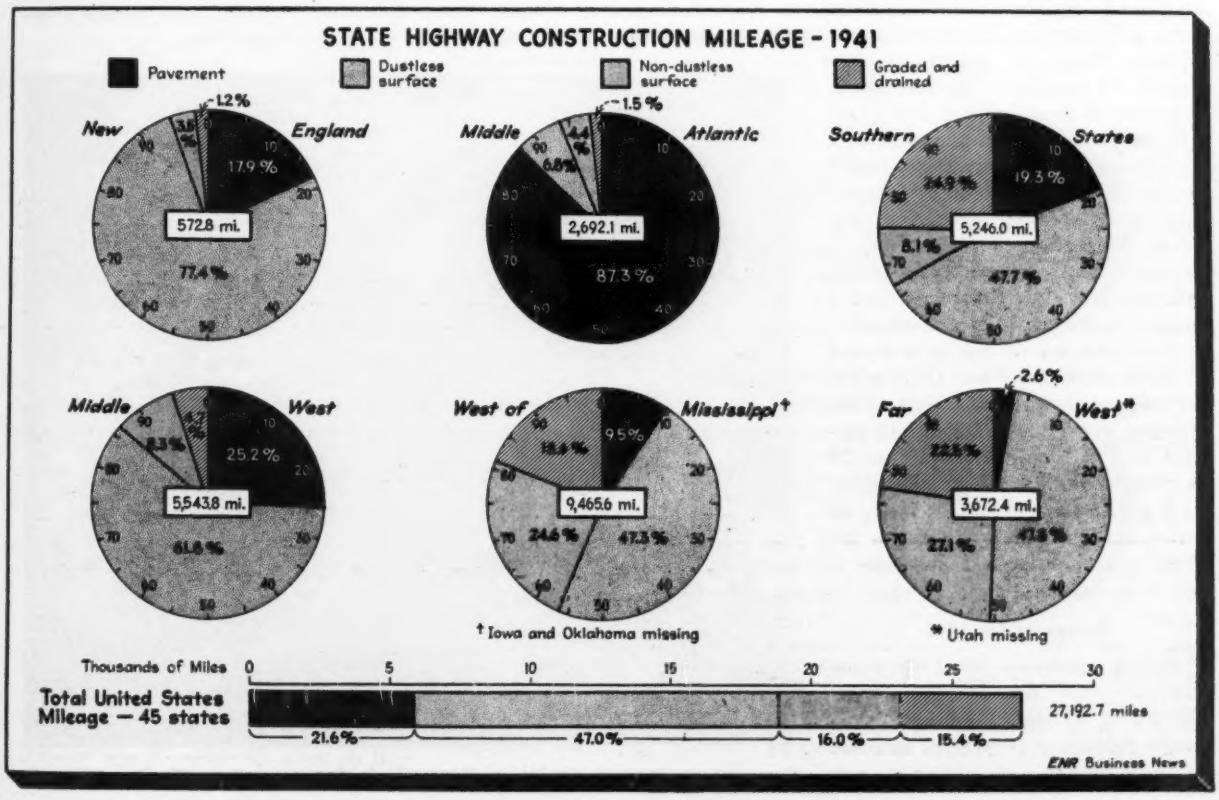
The percentage of the total highway funds spent for maintenance and equipment equaled the 1940 rate, the first year since 1938 that no decrease was recorded. At 32 percent, the ratio was well above the 27 and 29 percent shares reported, respectively, for 1936 and 1937.

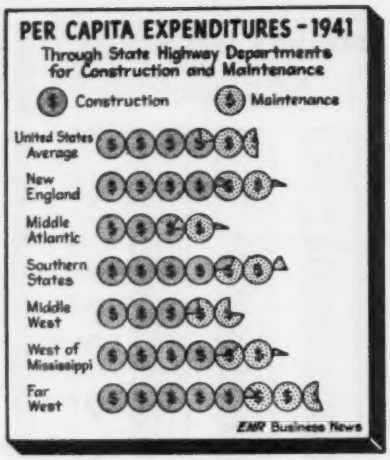
On a per capita basis, for the 46 states reporting, each person averaged an expenditure of $5.48 for 1941, with $3.81 going for construction, and $1.67 for maintenance and equipment. The highest per capita spending occurred in the Far West where each individual reached into his pocket for $7.57; construction taking $5.12, and maintenance $2.45. Residents of the Middle Atlantic states got off easier, with $4.09 being required from each person.



Despite the increase in construction expenditures over a year ago, state highway mileage built during 1941 was 18 percent lower than last year, according to the statistics from 44 states. This is easily explained, however, by the fact that during the past year 60 percent more miles of high-type pavement were constructed in these states than in 1940.

The mileage total for the year in 46 states (reports from Iowa and Utah missing) reached 27,046 miles. High-type pavement mileage made up 6,060





miles, or 22 percent of the total; dustless surfaced roadways accounted for 12,769 miles, or 47 percent; non-dustless surfacing 4,175 miles, or 16 percent; and new roads graded and drained, 4,042 miles, or 15 percent.

A geographical analysis of the high-type pavement mileage reveals that 39 percent of the total constructed during 1941 was in the Middle Atlantic states; 23 percent in the Middle West; 17 percent in the South, 18 percent in the West of Mississippi states; and less than 2 percent each in New England and the Far West.

Of the dustless surfaced roadway mileage, 35 percent was built in states west of Mississippi; 27 percent in the Middle West; 20 percent in the South; 14 percent in the Far West; 3 percent in New England, and 1 percent in the Middle Atlantic states.

Non-dustless highway mileage built during 1941 was divided as follows: west of Mississippi, 51 percent; Far West, 24 percent; Middle West, 11 percent; South, 10 percent; Middle Atlantic, less than 3 percent; and a negligible amount in New England.

A breakdown of the graded and drained roads shows that 1,602 miles, or 40 percent, was done West of the Mississippi; 1,308 miles, or 32 percent, in the South; 826 miles, or 20 percent, in the Far West; 258 miles, or 6 percent, in the Middle West; 40 miles, or less than 1 percent, in the Middle Atlantic states; and only 7 miles in New England.

Prospects for 1942

Budget estimates for 1942 made available to *Engineering News-Record* by 37 state highway departments indicate a 10 percent increase in construction, maintenance and equipment expenditures over 1941 in the states reporting. The 1942 budget total for these 37 states, $557,100,000, compares with $505,400,000 spent by these same states in the year just ended. It should be noted, however, that most of the budgets from which these figures are taken were prepared before war was declared and many are predicated on federal approval of, and aid for, work on the strategic network. Some states, in view of the emergency road authorizations of last November, even increased their construction budgets for 1942. This accounts in major part for the projected increase noted.

Budgeted expenditure estimates for 1942 by regions are: New England (Vermont missing), $51,800,000, up 8 percent; Middle Atlantic (New York and Pennsylvania missing), $27,600,000, down 4 percent; South (South Carolina, Georgia and Mississippi missing), $165,500,000, up 29 percent; Middle West (Illinois and Michigan missing), $83,900,000, up 9 percent; West of Mississippi (Iowa, and Arkansas missing), $147,500,000, up 4 percent; and Far West (Utah missing), $81,000,000, down about 2 percent.

In reconstruction of U. S. Route 1 near Baltimore, Maryland gave special attention to channelizing, adding acceleration lanes at intersections.

Deep cut to improve grades on Route 25 in Ste. Genevieve County, Missouri.

Access Roads and Strategic Network

***Contents in Brief**—During 1941 the Public Roads Administration and the state highway departments concentrated their operations on the strategic highways network. Preference also was given to access roads wherever federal-aid highway funds could be used for that purpose. The results for eleven months of the year, compiled by the Public Roads Administration, are given, largely in tabular form.*

A YEAR AGO the Public Roads Administration reported to the President that construction or improvement of 2,830 miles of road was needed to provide adequate access to 192 military reservations and defense industries, that 5,090 miles of road on the nation's strategic highway network needed widening, that 14,000 miles needed strengthening to meet minimum military requirements, and that 2,436 bridges on the network were too weak for the H-15 loading specified by the War Department.

Funds not forthcoming

No action was taken on these recommendations until June when the President asked Congress for $100,000,000 for access roads and $25,000,000 to be matched equally by the states for urgently needed work on the strategic network. He stated that up to that time, $54,400,000 of regular federal-aid money and WPA funds already had been used to finance 1,090 miles of access roads. Though legislation covering these recommendations was introduced immediately, nearly five months went by before legislation was finally approved. Thus it was not until November that the President signed a bill authorizing expenditure of $150,000,000 on access roads and $50,000,000 for work on the strategic network, half to be prorated to the states on the regular federal-aid basis to be matched by them on a 75-25 percent federal-state basis, and half to be unallocated. Even then no money was appropriated, this being simply an authorization. Actual appropriation of money did not come until after war was declared in December when $74,600,000 was appropriated for access roads and $50,000,000 additional in contract authorizations was approved. No money was provided for work on the strategic network.

The effect of this delay was to set back the access road work badly. Had it not been for the fact that the WPA had money that could be used for that purpose and was able to get states and other local government agencies to put up additional money as sponsors of access road projects, little would have been done. State highway departments had their hands tied in most instances by the legal requirement that federal-aid highway funds could not be spent on roads that were not part of the federal-aid highway system, which was the case with a large part of the needed access roads. Also, many state governments did not consider themselves justified in spending state funds on work that they believed should be paid for by the federal government as part of the defense program simply because Congress failed to provide the money.

Figures for WPA accomplishments for the year are not yet available; up

TABLE I—ACCESS ROAD PROJECTS APPROVED AND PROGRAMMED

Summary by Defense Classifications, Kind of Projects, and Construction Status As of November 30, 1941

(Compiled by the Public Roads Administration, Federal Works Agency)

	Total cost	Federal funds	Miles: Construction	Miles: Engineering	Number of structures	Number of grade crossing: Eliminations	Number of grade crossing: Protections
Defense classifications:							
Access roads	$19,456,585	$10,475,190	249.8	1,375.8	71	16	16
Reservation roads	381,507	263,512	12.0	229.0	1	.	1
Hawaii defense	420,482	412,758	6.1	8.2	1	..	..
Total	20,258,574	11,151,460	267.9	1,613.0	73	16	17
Kind of projects:							
Preliminary engineering	1,536,918	1,513,185	.....	1,487.0	..	..	..
Construction engineering	543,050	528,362	.....	126.0	..	..	..
Construction	18,178,606	9,109,913	267.9	.....	73	16	17
Total	20,258,574	11,151,460	267.9	1,613.0	73	16	17
Construction status:							
Approved, not under way	6,830,803	3,383,571	98.1	.....	29	10	13
Under way	10,373,595	6,124,091	112.9	7,362.5	40	6	2
Completed	3,054,176	1,643,798	56.9	250.5	4	..	2
Sub-total	20,258,574	11,151,460	267.9	1,613.0	73	16	17
Programmed only	9,761,166	6,143,134	86.9	208.5	22	19	11
Total approved and programmed	30,019,740	17,294,594	354.8	1,821.5	95	35	28

TABLE II—STRATEGIC NETWORK ROADS APPROVED AND PROGRAMMED

Summary by Kinds of Projects and Construction Status As of November 30, 1941

	Total cost	Federal funds	Miles: Construction	Miles: Engineering	Number of structures	Number of grade crossing: Eliminations	Number of grade crossing: Protections
Kind of projects:							
Preliminary engineering	$490,526	$310,526	.....	352.1	.....	...	...
Construction engineering	.....	.....	.....	.....	.....	...	...
Construction	205,955,968	111,878,281	4,868.3	.....	1,033	157	133
Total	206,446,494	112,188,807	4,868.3	352.1	1,033	157	133
Construction status:							
Approved, not under way	40,383,465	19,686,221	728.3	.....	177	21	45
Under way	106,736,785	58,900,199	2,086 3	287.5	537	81	10
Completed	59,326,244	33,602,387	2,053.7	64.6	319	55	78
Sub-total	206,446,494	112,188,807	4,868.3	352.1	1,033	157	133
Programmed only	60,998,325	29,186,992	1,104.3	19.5	93	38	36
Total approved and programmed	267,444,819	141,375,799	5,972.6	371.6	1,126	195	169

to the end of the fiscal year (June 30, 1941) it had spent $207,960,000 of its funds and $96,672,000 of sponsors funds, a total of nearly $305,000,000.

On the other hand, total expenditures of state and federal road funds on access roads to the end of November amounted to only $30,000,000, of which $17,300,000 was federal money. A summary of these expenditures is given in Table I.

Table II indicates that as soon as the funds for access roads that were appropriated a few days after war was declared are made available to the state highway departments they will be ready to put a large amount of work under contract. Engineering work had been completed by the end of November on 250 mi. of the 1,613 mi. of approved work, and preliminary engineering was underway on 1,362 mi. Construction of 57 mi. had been completed; 113 more miles were underway, and nearly 100 mi. had been approved for start of construction when funds became available.

Under new regulations adopted by the Public Roads Administration following the declaration of war, all access road projects are initiated by the Army or Navy and are immediately referred to the PRA district engineers who prepare general descriptions of the work to be done. Plans and specifications are then prepared by the state highway departments, and when these are approved by local military officials, the highway departments call for bids and let the contracts.

Work on the strategic network

Quite a different picture is given by statistics of work on the strategic highway network in Tables II and III. When Congress passed the biennial highway act in 1940 it recognized the growing importance of highways to the defense of this country by directing the Commissioner of Public Roads "to give priority of approval to projects on the strategic highway network." That policy has been vigorously pressed by the Public Roads Administration during the past year with the hearty cooperation of state highway departments. As a result, over $267,000,000 was spent on these roads in eleven months, a little more than half being federal money; 2,054 miles of road were completed, and over 2,000 miles were under construction at the end of November.

What work on the strategic network will be done this year is unknown. Soon after war was declared the PRA stopped clearing requests for priority assistance on any highway project except access roads. This does not mean that all other highway work is to be stopped, for much of it can go forward without priorities, but there may be curtailment if the manpower now engaged in road work is needed for war activities.

TABLE III—STRATEGIC NETWORK ROADS APPROVED, UNDER WAY AND COMPLETED AS OF NOVEMBER 30, 1941, BY STATE

State	Approved not under way				Under way				Completed				Total			
	Total cost	Federal funds	Miles Constr.	Miles Engr.	Total cost	Federal funds	Miles Constr.	Miles Engr.	Total cost	Federal funds	Miles Constr.	Miles Engr.	Total cost	Federal funds	Miles Constr.	Miles Engr.
Ala.	$709,500	$351,450	19.7		$662,716	$353,095	9.5		$908,518	$693,180	1.7		$2,280,734	$1,397,725	30.9	
Ariz.	384,302	254,599	8.4		1,601,215	1,150,424	48.5		1,072,147	804,858	32.3		3,057,664	2,209,881	89.2	
Ark.	104,315	57,992	12.4		779,644	426,741	38.9		738,805	455,254	21.8	21.0	1,622,764	939,987	73.1	21.0
Cal.	2,350,640	1,173,525	39.5		5,834,359	3,208,705	55.5		4,209,493	2,324,855	70.1		12,394,492	6,707,085	165.1	
Colo.	1,348,915	804,857	31.4		586,889	331,287	44.9		1,407,443	901,725	122.6		3,343,247	2,037,869	198.9	
Conn.	491,595	216,825	9.4		876,958	421,527	12.8		406,960	196,569	5.5		1,775,513	834,921	27.7	
Del.	309,859	235,419	6.3		211,252	105,626	5.4		85,153	42,361	2.5		606,264	383,406	14.2	
Fla.	1,042,296	504,176	16.4		739,063	424,839	7.7		344,024	235,550	4.9		2,125,384	1,164,564	29.0	
Ga.	418,064	282,749	5.6		309,669	222,781	16.3		349,014	158,090	8.6		1,076,746	663,620	30.5	
Idaho	209,549	129,564	1.1		537,698	364,546	11.7		1,111,586	678,938	57.1		1,858,832	1,173,049	69.9	
Ill.	358,639	333,189	.3		3,781,453	2,061,911	38.5		1,113,080	561,488	10.4		5,253,172	2,956,588	49.7	
Ind.	1,952,593	978,044	28.2		4,571,650	2,338,951	56.2		1,228,061	551,492	15.1		7,752,304	3,868,487	99.5	
Iowa					772,258	461,126	7.0		246,683	151,500	5.3		1,018,941	612,626	12.3	
Kans.	670,383	247,855	8.8		667,276	333,638	35.5		979,715	485,480	49.6		2,317,374	1,066,973	93.9	
Ky.	1,890,707	945,353	5.1		3,376,378	1,704,648	67.8		1,385,302	696,072	65.7		6,652,386	3,346,073	138.6	
La.	2,427,208	1,369,020	57.7		1,914,554	1,184,335	42.2		1,184,644	758,690	24.9		5,526,405	3,312,045	124.8	
Me.	80,471	41,166	.1		2,132,176	1,206,817	23.7	44.0	817,947	405,238	21.4	3.5	3,030,595	1,653,222	45.2	47.5
Md.	7,250	7,250			1,705,185	842,194	14.3	42.0	672,260	336,130	5.9		2,384,696	1,185,574	20.2	42.0
Mass.	926,331	460,769	5.9		1,442,912	871,814	7.6		1,883,811	937,689	15.0		4,253,054	2,270,271	28.5	
Mich.	476,380	257,430	4.2		2,968,185	1,689,985	38.1		4,375,986	2,233,604	106.6		7,720,551	4,181,019	148.9	
Minn.	203,825	174,150	1.3		3,364,359	1,736,108	109.2		1,494,291	766,487	85.2		5,062,475	2,676,745	195.7	
Miss.	53,000	28,000			778,699	557,499	8.8		1,579,000	779,500	65.0		2,411,299	1,364,999	73.8	
Mo.	2,262,201	340,205	29.8		2,659,916	940,198	38.5		897,356	446,510	24.4		5,819,473	1,726,913	92.7	
Mont.	493,204	280,436	31.6		1,182,348	671,549	25.2		1,294,181	847,287	42.3		2,969,733	1,799,372	99.1	
Neb.	16,004	8,002			760,967	448,729	61.0		294,000	133,079	34.6		1,070,971	594,810	95.6	
Nev.	355,628	319,643	24.1		1,004,790	877,981	31.1		1,713,257	1,497,302	101.2		3,073,675	2,694,926	156.4	
N. H.	456,504	229,913	5.4		1,251,334	695,416	13.8		723,825	391,285	15.7		2,431,663	1,316,615	34.9	
N. J.	23,910	11,955			2,968,530	1,524,120	16.3		359,576	286,744	.6		3,352,016	1,822,819	16.9	
N. Mex.	366,882	238,013	17.8		622,657	402,610	43.6		690,223	437,770	29.4		1,679,762	1,078,394	90.8	
N. Y.	1,521,580	685,450	14.1		7,166,111	3,793,160	86.0	9.0	3,312,669	1,726,620	46.8		12,000,360	6,205,230	146.9	9.0
N. C.	58,180	29,090	.9		1,077,014	632,480	24.0		1,489,167	880,888	32.9		2,624,361	1,542,467	57.8	
N. Dak.	497,400	248,700	44.5		1,045,891	699,201	67.9	186.3	1,149,221	647,981	112.1	19.1	2,692,512	1,595,883	224.5	205.4
Ohio	4,695,200	1,846,818	18.5		4,775,240	2,689,335	28.4		1,533,450	768,195	17.8		11,003,980	5,304,348	64.7	
Okla.	1,088,455	611,959	30.7		939,053	721,695	22.7		528,303	280,987	16.7		2,555,811	1,614,640	70.1	
Ore.	586,886	367,555	8.2		3,196,341	1,692,997	53.0		2,509,006	1,578,766	118.1		6,292,234	3,639,318	179.3	
Pa.	3,013,126	1,583,852	24.4		7,568,661	4,392,307	49.2		1,991,742	1,095,269	22.4		12,573,529	7,071,428	96.0	
R. I.					586,262	293,111	4.6		818,742	407,995	6.2		1,405,004	701,106	10.8	
S. C.	1,090,850	371,085	17.1		2,127,400	1,070,207	24.6		563,718	289,515	37.9		3,781,968	1,730,807	79.6	
S. Dak.	88,300	67,650	20.6		1,391,610	877,550	147.7		895,695	634,955	148.6		2,375,604	1,580,155	316.9	
Tenn.	894,144	493,802	18.9		1,366,006	728,862	9.9		1,031,737	515,867	21.5	21.0	3,291,887	1,738,531	50.3	21.0
Texas	4,288,432	1,958,753	144.1		8,640,661	4,636,551	282.0		3,580,208	1,842,113	168.1		16,509,302	8,437,417	594.2	
Utah	3,691	3,691			1,730,519	1,313,356	37.4		717,494	556,166	23.2		2,451,704	1,873,112	60.6	
Vt.	83,420	41,710	1.4		1,314,137	776,398	17.1		642,012	320,419	18.9		2,039,568	1,138,527	37.4	
Va.	757,060	375,480	5.7		2,898,774	1,433,186	49.2		1,567,523	844,185	33.8		5,223,357	2,652,851	88.7	
Wash.	553,750	271,214	5.4		2,927,407	1,373,166	33.0		918,036	497,290	28.9		4,099,194	2,141,670	67.3	
W. Va.					1,784,979	883,470	24.2		860,600	469,033	11.1		2,645,579	1,352,503	35.3	
Wis.	97,668	49,428	.1		3,410,951	1,554,040	103.3		412,198	202,487	17.5		3,920,817	1,805,954	120.9	
Wyo.					1,046,258	666,863	77.4		1,042,665	696,303	123.9		2,088,923	1,363,166	201.3	
Hawaii	299,491	149,745	1.7		26,000	26,000		6.2					325,491	175,745	1.7	6.2
Dist. of Col.					140,642	70,300	.9		295,117	147,526	1.9		435,759	217,826	2.8	
Puerto Rico	375,587	248,690	1.0		1,811,778	1,016,855	14.2						2,187,365	1,265,545	15.2	
Total	40,383,465	19,686,221	728.3		106,736,765	58,900,199	2,086.3	287.5	59,326,244	33,602,387	2,053.7	64.6	206,446,494	112,188,807	4,868.3	352.1

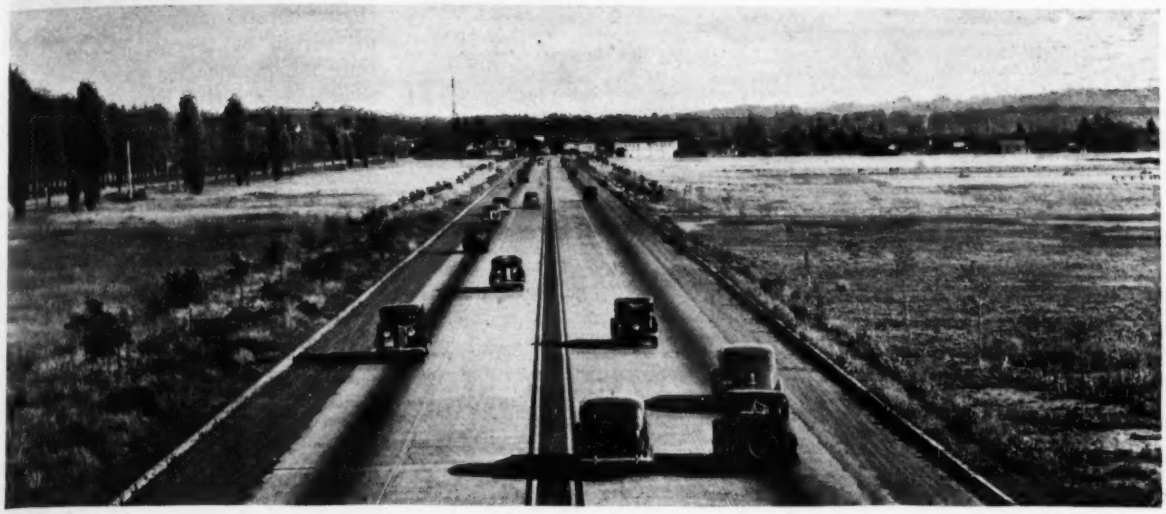


Fig. 1. Contrasting center strips are widely used where right-of-way does not permit use of more definite separation.

Current Divided-Highway Design Practices

***Contents in Brief**—Advances made recently in the design of divided highways are reported, supplementing information compiled by this journal two years ago. Applications of the freeway principle is growing in acceptance as the best way to maintain traffic capacity; wide median zones are more commonly used, acceleration and deceleration lanes are provided at important intersections, and channelization is employed to reduce traffic hazards. Reflecting curbs of white concrete are employed to define median zones and channels at intersections.*

DIVIDED HIGHWAYS now are universally accepted as the ultimate objective in the design of new main roads or in the reconstruction of old ones. Each year more states are added to the number adopting this type of design and each year new mileage is added to the very considerable mileage now in service.

Over two years ago this journal made a compilation of current practices in the design of divided highways and that information was published in a series of three articles beginning in the issue of December 21, 1939. Since then a considerable number of new highways have been built and much experience has been gained with existing roads. This article brings that information together in concise form. It is a summary of statements supplied by engineers of the highway departments of most states in which divided highways have been built or are projected.

Most noteworthy among recent developments is the growing acceptance of the "limited-access" or "freeway" principle in highway legislation. This limitation on access to the highways, taken in conjunction with authority to purchase wide rights-of-way, is being employed to keep the capacity of new major highways from being curtailed by the development of "ribbon cities" along the edge of the roadway and by the hazards inherent in frequent points of ingress to the highway. In some states the highway commission now is authorized to designate certain highways as freeways, and in other states the access rights of property owners can be acquired by the commission through condemnation proceedings. Colorado recently passed a law of the latter type, and the 1941 general assembly of Maryland adopted a freeway law for the purpose of controlling developments adjacent to new highways and to insure additional widths of right-of-way that will make possible the construction of service roads, limit access to the main highway, and permit elimination of parking on the main highway throughout thickly developed areas. Ohio and Michigan also adopted freeway laws in 1941.

Wider use of grade separations at intersections with other main highways is a trend that is inevitably tied to the wider use of the freeway principle. The Pennsylvania Turnpike is the outstanding example of this, there being no grade crossing in its 160-mile length.

Highway cross-sections

There is no evidence of a trend toward standardization of cross-sections for divided highways. If anything, the trend is away from standardization, each cross-section being adapted to suit local needs. This is evident in the cross-sections shown in Figs. 2 and 3. Even the sections here shown, in most instances, are not standard within the state itself, one section being used in congested areas and others in the open country. The

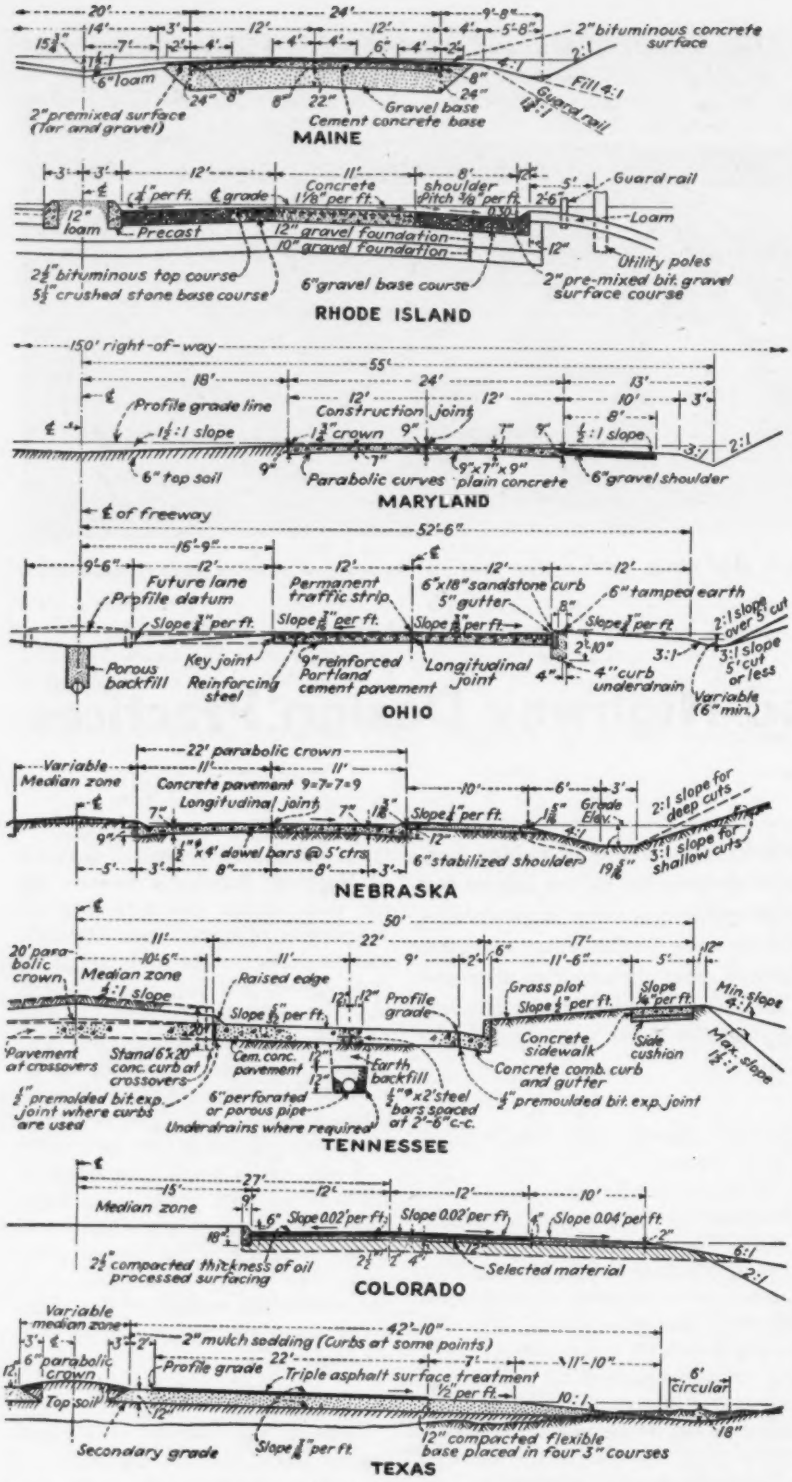


Fig. 2. Half-sections of divided highways showing the range of designs now in use. The projected design for Maine is one of those in which a depressed median zone is used for snow storage (See also Minnesota, Fig. 3). Rhode Island uses rough-surfaced passing lanes of contrasting color to keep traffic in the traveling lanes. Several states are using wide median zones to give flexibility in adding traffic lanes or lanes for acceleration or deceleration at intersections. Crowning from the median zone as is done in Texas is not favored in states where ice forms on the pavement.

sections reproduced have been included here to indicate how wide is the variety of designs, also to illustrate the manner in which varying conditions are met, lane spacing and lane grades being adjusted to the topography. Outstanding examples of this are Mississippi's Gulf Coast highway, some of the divided sections of New York's Eastern State Parkway, and the Arroyo Seco Parkway in California.

Lanes at varying levels

Lanes at varying levels are employed frequently where existing two-lane roads are converted into dual highways, first, because a departure from the grade of the old road permits better adaptation of the new lanes to the topography, and second, because of changes in standards for grades, curves and sight distances since the old road was built.

Missouri uses median zones from 30 to 50 ft. wide in such reconstruction work because of the greater flexibility in grades given by the wider zone.

An interesting outgrowth of the design of four-lane highways in Louisiana has arisen out of the fact that many of the existing two-lane highways were constructed parallel to railway tracks, and the embankment usually was secured from side borrow which left a rather deep ditch, usually on the side of the highway opposite from the railroad tracks. To avoid unnecessary expense involved in backfilling these ditches, when four-lane highways are constructed, it is the practice to employ a wide neutral ground, possibly 100 ft., and to build two additional lanes of pavement with appropriate connections to the existing pavement. This type of construction was applied to the 20-mile access road to Camp Claiborne. On that project it had the advantage of permitting the road to be improved without interfering with the heavy military traffic.

Provision for service roads

All present designs for divided highways in Louisiana provide for the future construction of service roads separated from the traffic lanes by at least a 20-ft. neutral ground. Similarly, in other states, use of service roads is accepted as a highly desirable adjunct to freeways where they are built through congested

areas, examples being Henry Hudson Parkway in New York, the projected new highway through Santa Fe, N. M., and State Route 61 in Montgomery County, Ohio.

Future lanes

Another practice that is finding increasing acceptance is the use of a median zone of sufficient width to permit the addition of two more lanes, making a six-lane road when conditions demand it. An example of this is the Ohio highway shown in Fig. 2. On that highway Ohio used a 33-ft. 6-in. median zone which permits the addition of two 12-ft. lanes in the future while still retaining a median one 9-ft. 6-in. wide.

Provision for acceleration and deceleration lanes is another practice that is finding increased acceptance. The most notable example of this is the Pennsylvania Turnpike where lanes are added on the right-hand side for a distance of 1,200 ft. on each side of the points where traffic turns off or comes on from the separated crossroads. Some states are

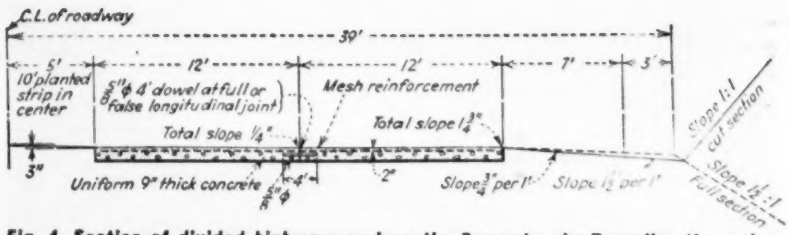


Fig. 4. Section of divided highway used on the Pennsylvania Turnpike, the major superhighway in this country.

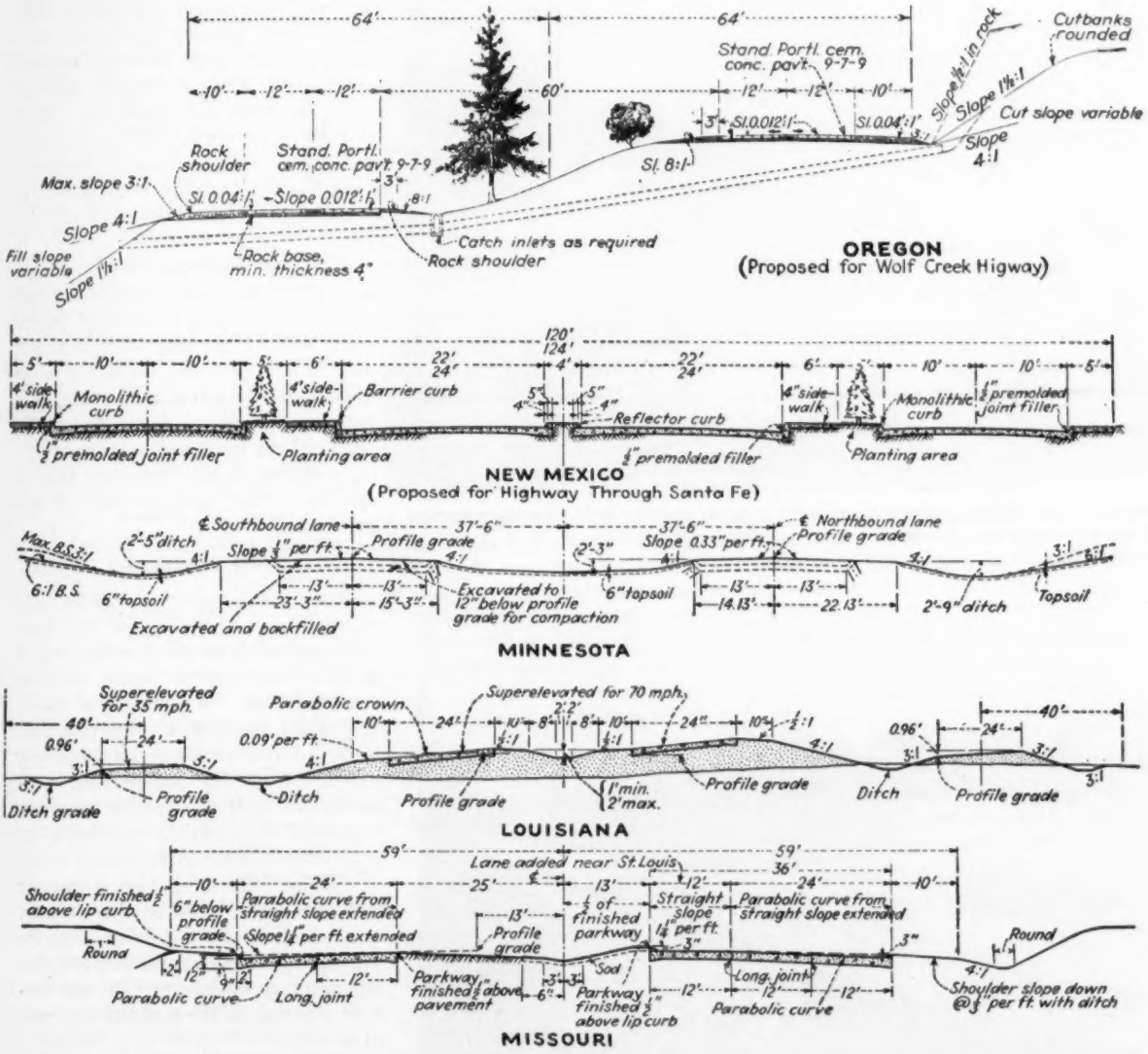


Fig. 3. Varying methods for adapting divided highways to local conditions are shown in these sections from five states. Minnesota's section is notable as the most advanced in providing for snow, being streamlined and free from curbs, which interfere with snowplows. Wide ditches and a depressed median zone increase snow storage space and insure that snow water will not get on the pavement to freeze. Louisiana superelevates service roads for lower speeds than the main road.

Fig. 5. Construction of separate bridges for each roadway is gaining in acceptance as preferable to the narrowing of the median zone. Here shown are the Willow Branch bridges near San Marcos, Texas.

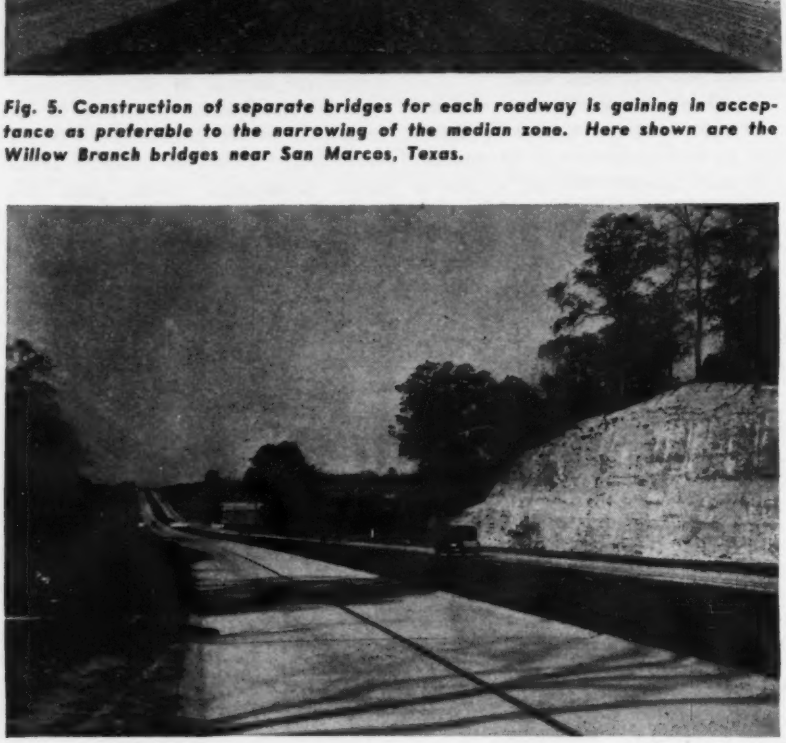


Fig. 6. When divided highways are built in open country both adequate median zones and adequate shoulders can be provided. Here shown is U. S. Route 40 west of St. Louis.

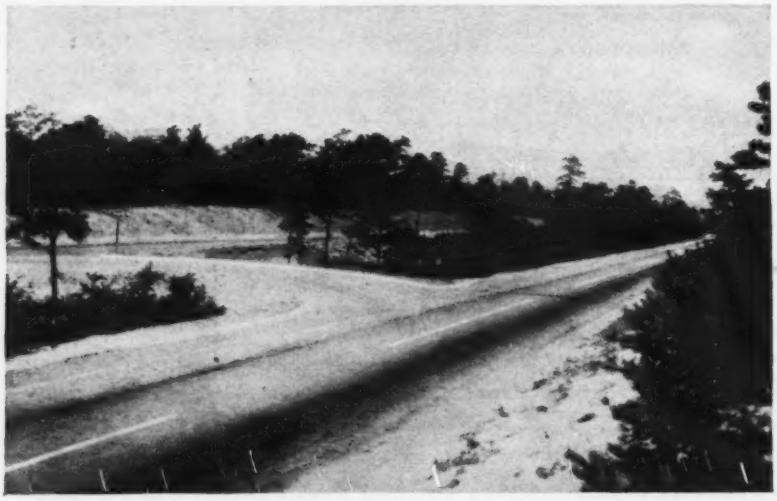


Fig. 7. A crossover on State Route 28 near Bourne, Mass., where an unusually wide median zone is used. Wide zones require longer crossovers but make curbing unnecessary. Natural growth is encouraged in the zones.

adopting deceleration lanes on the left-hand side at points where grades are not separated to give vehicles planning to make a left turn an opportunity to clear the fast lane as they approach the intersection.

Provision for snow

In some of the northern states, provision for disposal of snow clear of the traveled lanes is a major factor affecting the choice of highway cross-sections. Minnesota has found that a streamlined section with a wide-dished median zone frequently can be provided at only a nominal cost for an increased width of right-of-way, thus permitting use of a fairly deep depression in the median zone without hazardous or unsightly features. This greatly facilitates disposal of snow when plowing becomes necessary. The depressed median zone increases the space for snow storage and also takes the water from melting snow away from the roadway (See Fig. 3). Similar considerations dictated the Maine design shown in Fig. 2.

The New York Division of Highways has come to the conclusion that through rural areas a saucered center mall, without curbing alongside the pavement, is probably the best type of divided-lane construction. This permits the piling of snow from the center of the road and, with no curbing to interfere, the plows are able to operate to the extreme edge of the pavement.

Stage development

Many states now are purchasing right-of-way and laying out new two-lane roads with future development of divided four-lane or even six-lane roads in view. When this is done, overpasses are built to span the full width of the ultimate development, but structures for underpasses, generally, are built only for the two-lane highway. Connecticut is applying stage development to the eastern end of Wilbur Cross Parkway where traffic is lighter than on the western end, which is being developed to its full width. Maryland permits adjoining property owners to cultivate unused portions of the right-of-way until needed.

Lane widths

Use of 12-foot lanes appears to be gaining, but that width is far from being standardized as will be seen

from Figs. 2 and 3. That 9-ft. and 10-ft. lanes are rapidly passing out of consideration is evident in the fact that the American Association of State Highway Officials in "A Policy for Highway Types" sets the minimum roadway width for divided highways at 22 ft. The association makes no specific recommendation for lane width on divided highways in this pamphlet, but assumes an 11-ft. lane in its studies of desirable width of median zones for such highways.

Rhode Island and Ohio have done some experimenting with the effect that lanes of different color and varying surface characteristics have on travel. Ohio built U. S. Route 20 from Painesville to Conneaut with 11-ft. outer lanes of portland-cement concrete and 10-ft. passing lanes of asphaltic concrete. This color contrast was found to keep traffic in line better than was the case on an adjacent section of the same highway which has four lanes of the same color. Rhode Island, in the initial work of reconstructing U. S. Route 1 through that state, adopted the cross-section shown in Fig. 2, in which the passing lane of bituminous macadam has a surface which was purposely made quite open so that it would register on the driver and so help keep him in the traveling lane except when passing. In current work the highway department is using a smoother surface on the bituminous material to make it less noisy under fast traffic but is retaining the color contrast.

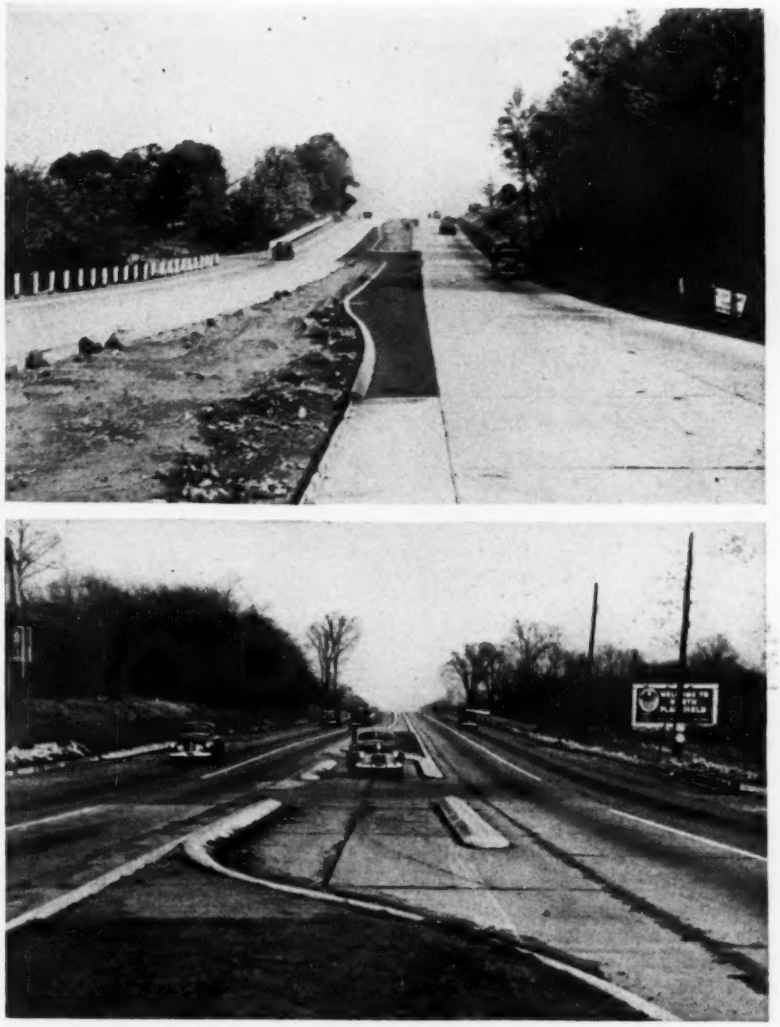


Fig. 8. Channeling at intersections and provision of additional lane width at intersections are gaining in favor. The upper picture is on the Wilbur Cross Parkway in Connecticut, and the lower one shows how cars on State Route 29 in New Jersey are protected while waiting for a left turn at a minor intersection.

Roadway crown

No uniformity is found in crowning of roadways on divided highways, but the trend on new construction where an unpaved medium zone is used favors crowning each roadway so that it slopes from the center. On widened roads or on roads in congested areas where opposing traffic can only be separated by a concrete separator or by surface marking, drainage quite generally is across pavement from the center strip.

In northern states where ice on the pavement presents a special hazard, care is exercised in keeping water on the median zone from getting out on the pavement. Massachusetts, for example, not only crowns each roadway so that water from the median strip will not cross the pavement but also superelevates each roadway separately on curves, the median strip being pitched against the superelevation.

An outline of current practices in handling cross drainage and in disposal of runoff on divided highways was published in *ENR* January 2, 1941, p. 24.

Wider median zones used

Median zone widths have increased progressively since divided highways first were built; one exception to that general statement is California, where the first divided highway had a zone width of 20 ft. and one built in 1938 had a 50-ft. zone. (*ENR* Jan. 28, 1940, p. 176). Widths of 20 ft. or more are now quite common on new work outside of congested areas where land values do not make such wide ones too costly. A few highway engineers are questioning the justification for median zones wider than those needed for protection at intersections on roads having frequent left-hand turns or to minimize the effect of headlights in the opposing lanes. In congested areas where marginal friction is serious, the California highway department favor increasing the medial and intersectional friction by reducing median zone width to give extra shoulder widths.

Wide median zones add to the cost of bridges, culverts, overpasses and underpasses. Early practice was to narrow the median zone at major structures, but that practice is less evident in the highways that have been recently constructed.

Fig. 9. Scoring white concrete curb faces along Peterson Ave., Chicago. Early types of light-reflecting curbs were precast, but scoring now is gaining in favor.

A major factor in determining median-zone widths is reduction of friction at intersections where there is left turning or crossing at grade. At such points the desired objective is to create a protected zone in which the turning or crossing vehicle can stand clear of the traveled lanes of one roadway while waiting for movement across or into the lanes of the opposing roadway. How best to meet that objective was the subject of an exhaustive study by the A.A.S.H.O., which is reported in "A Policy on Highway Types" and in *ENR*, Oct. 26, 1939, p. 534. Median-zone widths and lengths of opening in the zone as determined by that study vary widely, depending on whether provision must be made for passenger vehicles or trucks, also whether the projected turn is into the crossing road or a U-turn on the divided highway. The minimum zone width that gives protection to the standing vehicle was found to be 12 ft. for passenger vehicles and 16 ft. for trucks or buses. Generally speaking, current practice appears to follow the A.A.S.H.O. recommendations with respect to widths required for left turns, but there is little evidence that any state is providing the much wider width that is necessary for U-turns, unless other considerations dictate the greater width. Channelizing at intersections is gaining in acceptance.

Spacing of crossovers

Spacing of crossovers is one of the difficult problems faced by highway engineers when existing two or three-lane roads are being converted into divided highways. Past practice has been to yield to the importunities of property owners and install crossovers at frequent intervals. That this added cost is unnecessary is indicated by California's investigation of that subject, as reported in *ENR*, Jan. 29, p. 178. Lack of crossovers does not cut down the business of commercial operators.

Curbs

Thinking with respect to curbs for median-zones appears to have gone through an almost complete cycle from barrier-type curbs to low, sloping curbs or no curbs, and now back to a definite, but not insurmountable curb. Early curbs of simple type with vertical or steeply sloping faces were succeeded by various types of flatly sloping curbs. This change was due in part to the development of reflecting types of curbs of white concrete, which, without increasing the height, can be made wider and more conspicuous by making them flatter; but it was due in part to a belief that the wider median zones should be a safety zone to which a vehicle in trouble can resort. This still is the accepted view, but experience has shown that a low curb tends to encourage crossing the median zone or driving onto it as a convenient stopping place. West Virginia reports that its low, sloping curbs are mounted so frequently as to make necessary much reshaping and reseeding of its earth-filled islands. Present plans in that state are to make curbs more difficult to mount. A similar trend is reported from Oregon, Missouri and Nebraska. Virginia used 6-in. curbs on early work but now uses lip curbs or sloping curbs.

Maryland does not use a curb along median zones except where the zone is very narrow; at such points, a sloping curb that develops a definite separation is used. Elsewhere curbing is omitted because it has a tendency to narrow the adjacent lane. Where curbs are not used, the surface of the median zone adjacent to the pavement is stabilized.

Barrier curbs are used quite generally at bridges and other points of special hazard.

White concrete curbs with precast or scored reflecting faces are gaining in acceptance, not only for median zones but for outer curbs and for channelizing at intersections. Many ingenious types of these light-reflecting curbs now are in use.

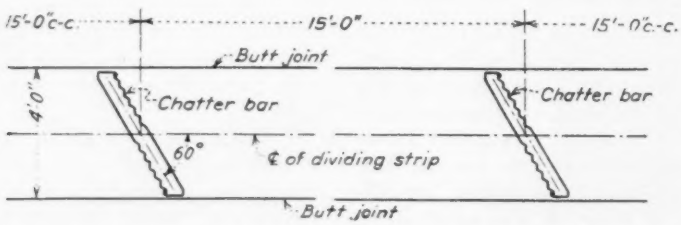


Fig. 10. Kentucky is using chatter bars one and one half inches high of this novel design on flush dividing strips to keep traffic from encroaching on the strip. Reflector buttons are cast into the outer end of the front faces.

Fig. 1. Treated timber bridge with a laminated timber deck over Barren Creek in Maryland.

Attention Turned to Timber Bridges By Priorities on Structural Steel

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***Contents in Brief**—Scarcity of structural steel for highway bridge construction revives interest in timber for moderate span bridges. Studies made in Maryland to develop a satisfactory low-cost bridge for the many water crossings in the tidewater regions of the state show that structures made almost wholly of treated timber or composite structures of treated timber and concrete have possibilities in low-cost, long and satisfactory service and pleasing appearance not generally realized. Tests on composite decks indicate that they may be found useful for major bridges.*

THE PRESIDENT WARNS of a long war, and we begin to take stock of materials available for bridge construction in the next few years. Highway programs may be reduced to work on only those roads that are of military importance, but even these roads must have bridges in many instances, hence, with the urgent need for steel for war purposes, it is imperative that bridge engineers make the most of substitute materials. And if roads for non-military purposes are built there is strong likelihood that we will by necessity be forced to turn to materials other than steel for the bridges.

Timber was a standard construction material for both highway and railroad bridges in the early days of road and rail transport in this country, but because of the relatively short life of the untreated timber of those days, the fire risk and the limited knowledge of how to make the most of its structural properties, it fell from favor to such an extent that even today with preservative treatment, better knowledge of its structural properties, and of how to minimize the fire risk, timber is not used in many places where it can show large savings as compared to steel and concrete. In view of this and of the consequent need for a better understanding of the part timber can play in our war economy, it is the purpose of this article to tell what the Maryland State Road Commission has learned in the past few years of the possibilities of timber as a bridge material through its use in the tidewater section of the state. Of special significance is the knowledge we have gained of the advantages of composite decks of timber and concrete. This type of construction appears to have possibilities that have not been adequately explored.

The tidewater section of Maryland comprises a large part of the state. Within it lies an intricate network of highways, railways, streams, estuaries and canals, making crossings of major importance necessary in many instances. Climatic conditions and storm-driven floods operate in one way or another to threaten or curtail the life of these structures. Humidity and the proximity to salt water stimulate and intensify corrosive action on metals; concrete is subject to disintegration, and timber to decay and to attacks of marine borers. Add heavy traffic and it is obvious that bridges in Maryland must meet a rigorous test if they are to afford reasonable assurance of general applicability, durability and serviceability. Further, in highly developed

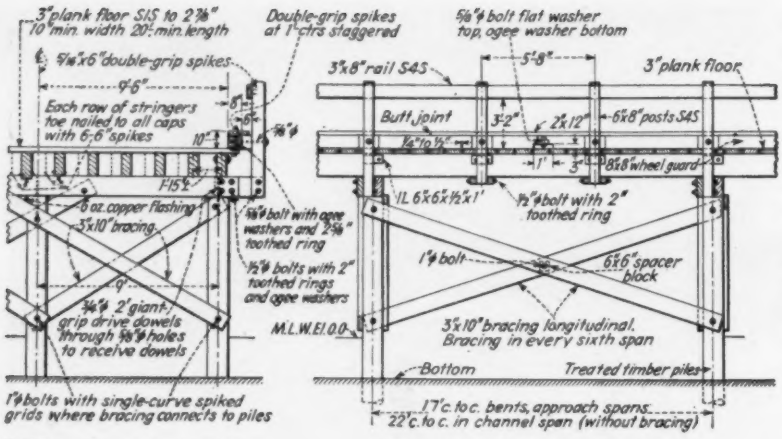


Fig. 2. Trestle of all-timber construction at Deal Island. All timber is treated except the rails, which are of untreated timber painted white. All metal parts are galvanized and the tops of piles are capped with sheets of copper.

areas appearance cannot be disregarded.

Short span bridge or drainage structures constitute the major portion of those on the roads of this state. In this group, at one end, is found the untreated timber structure which, in first cost, is cheapest but is unsatisfactory because of short life, coupled with high maintenance expense, possible fire damage, and its general unsatisfactory appearance. At the other end of the group we find the reinforced-concrete structure with a long life, low maintenance expense and adaptability to architectural treatment. This structure is much higher in first cost than conditions in many sections warrant. Especially is this true in those areas separated by salt-water marshes and where the traffic is extremely light.

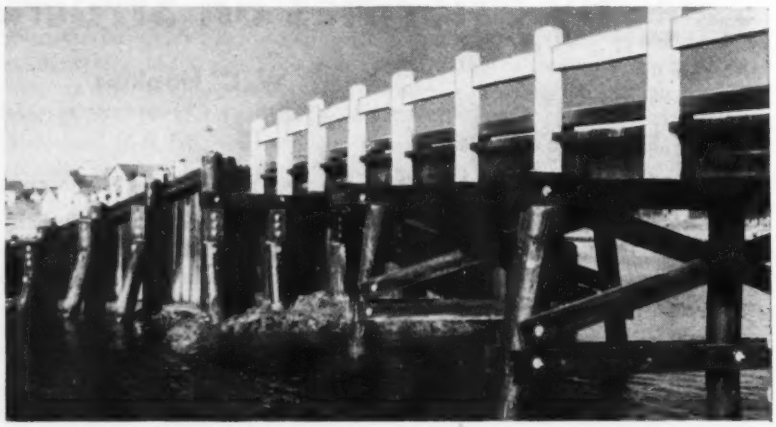
Comparative costs

The difference in cost of these two types is of wide range. Concrete structures with a life of 50 to 70 years or more, could be built until recently for $5.50 per sq.ft. Untreated timber structure, with a life of five to ten years, could be built in 1941, for $1.30 per sq.ft. With untreated timber structures, there is always the possibility of fire and high maintenance cost and the inconvenience to traffice because of delays and detours necessary in frequent reconstruction. This type of structure could only be considered for use where traffic is very light and the inconvenience caused by frequent repairs and renewals is of little consequence.

These conditions, therefore, naturally suggest the use of a type of structure between the ranges described above. Studies show that steel I-beams have been used in this class quite extensively; but the cost, if concrete substructure and deck are used, is approximately the cost of the concrete structure. Should steel I-beams be used with a timber substructure and deck, the maintenance expense is still high, fire damage is possible, and architectural treatment cramped. To meet the needs for an intermediate-type structure, the Maryland State Roads Commission has made extensive use of the creosoted timber trestle and the composite timber and concrete structure.

Creosoted timber trestles

For many years railroad and highway engineers have successfully constructed treated timber bridges and trestles; and while the trestles still involves considerable fire hazard, high maintenance expense for roadway decks and a lack of adaptability to architectural treatment, it is, because of its life and cost, a satisfactory structure for many locations. A bridge of this type, properly designed, has



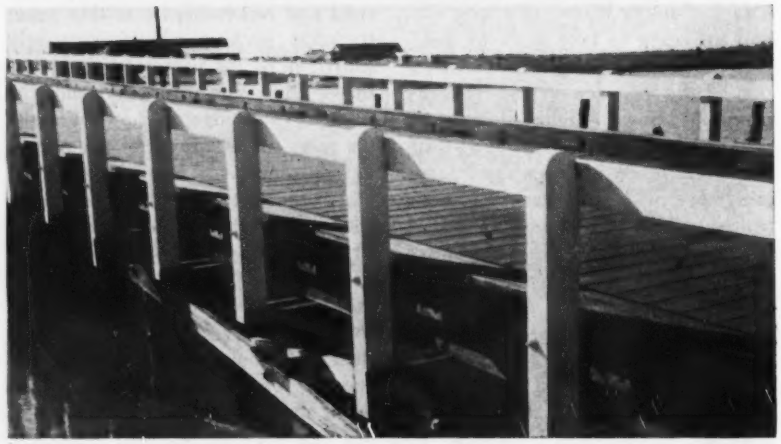


Fig. 3. Details of typical timber bridges in the tidewater district of Maryland. The upper view is a trestle over Jenkins Creek, and the lower view is of the Deal Island Bridge, shown in Fig. 2.

a low first cost and where traffic is not heavy and where deck material is carefully chosen, the maintenance cost can be reduced. A well-designed and built bridge of this type should have a service life of 40 years or more. Should traffic increase, demanding a wider roadway, the structure is easily adapted to such revamping and is also high in salvage value. Bridges of this type designed for H-15 loading were built in 1941 in this state for approximately $1.85 per sq.ft.

A trestle of this type, connecting Deal Island, Md., with the mainland, is shown in Figs. 2 and 3. It has a total length of 1,331 ft., a 19-ft. clear roadway, and was built in 1940 at a contract cost of $1.87 per sq.ft. It carries an average daily traffic of 237 passenger cars and 155 trucks.

The waters this bridge cross are highly infested with teredo, hence the piling was treated with 20 lb. of Grade No. 1 creosote oil per cu.ft. which is standard in Maryland for treatment of timber immersed in brackish or salt water. The specifications provided that penetration in not less than 75 percent of the piles should be 100 percent of the sapwood and that in the remaining 25 percent of the piles penetration should be not less than 4 in. unless 90 percent of the sapwood is penetrated; if any charge fails to meet these requirements only those piles showing 100 percent of the sapwood penetrated are accepted.

Southern yellow pine was specified for the floor planking and stringers, to be of structural joist and plank, or beam and stringer grade, 1,400 lb. per sq.in. All other timber, except backwalls, blocks, wheelguards and posts, was southern yellow pine, 1,200 lb. per sq.in., structural joist and plank or beam and stringer grade, or southern yellow pine, structural post and timber grade. Both timber and creosote oil grades are those of the American Association of State Highway Officials. The timber deck above caps was treated with 8 lb. of oil per cu.ft. except posts and rails, which were untreated. All timber below the deck contained 20 lb. of oil per cu.ft. Railing posts and rails were painted. All hardware, connectors, etc., were galvanized. Material was not preframed but all cuts and bolt holes were treated in the field.

Similar specifications and details are used at the present time by the Maryland commission in the construction of treated timber trestles and bridges.

Among other structures of this type recently completed some variation in the designs have been made. Creosoted black gum for the deck has been used, and in some structures, the strip or laminated deck consisted usually of 2x4's or 2x6's on edge and laid normal to the stringers, thus offering a type of continuous-slab construction and better distribution of the load. In some instances, continuous decks of lumber laid longitudinally on edge to form a laminated slab have been used satisfactorily. The laminated deck should be protected with a wearing surface such as a bituminous mat, asphalt plank or other types of surfacing. The selection often depends on the amount and type of traffic.

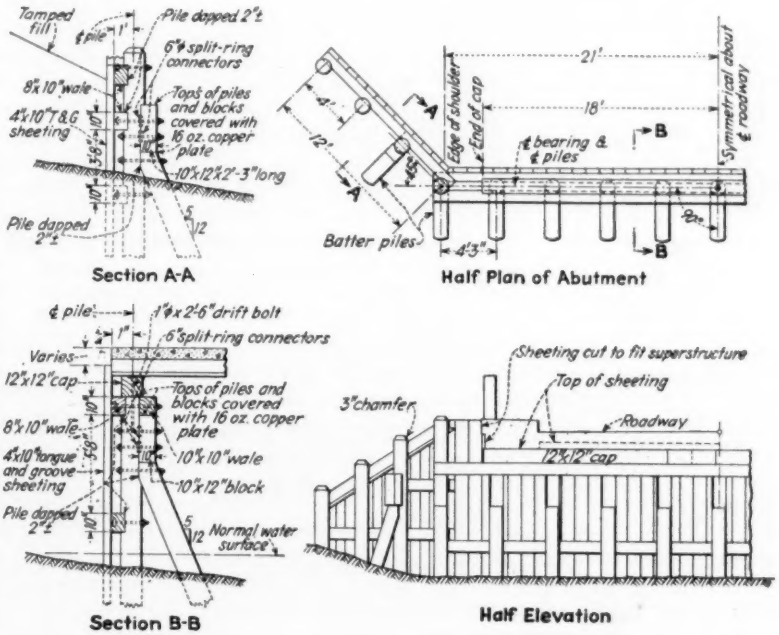


Fig. 4. Treated pile and timber abutment for the composite timber-concrete bridge over Tonytank Pond, details of which are shown in Fig. 6.

Decks of timber and concrete

In locations where traffic is greater or where a higher type of structure is required, the Maryland commission uses a combination of a creosoted timber substructure supporting a composite timber-concrete deck in which the timber and concrete are so rigidly interlocked as to be transformed into a unit adequate for bridge decks designed for the heaviest standard highway loadings. Joists and stringer systems are not required; and the concrete mat, in addition to forming an integral part of the supporting medium, provides an excellent and durable surface for vehicular traffic of all kinds.

For span lengths ordinarily used in trestle construction, all plank should be full panel length, usually laid immediately on the support in a direction parallel to the roadway center line. In multiple span construction, where a continuous, unbroken deck is often desirable, one-third of the laminations are butt-jointed over the support centers and one-third at or near each quarter-span point, the joints being made in regular rotation. In this arrangement two-thirds of the strips extend across and are effective at any of these points, and a full timber section extends throughout the mid-span reach between quarter points. Other arrangements of the timbers are possible but at least two-thirds of the strips should be continuous across splice points. Shear developers usually have thickness of $\frac{3}{32}$ in., and when driven, their bases protrude $\frac{1}{2}$ in. above the timber to engage the concrete mat.

In addition to the shear developers, uplift spikes are driven into the rigid laminations of this timber sub-

Fig. 5. Roadway of the Hooper Island trestle, which includes a swing-span with steel framing below the deck.

base at intervals of from 2 to 4 ft. These have a good penetration in the timber and their protruding heads are embedded well in the concrete to preclude any tendency to vertical separation between the concrete and the timber due to the differential temperatures on its top and bottom surfaces. No value, however, is allotted to the spikes in computing the shear connection.

The concrete mat is reinforced for shrinkage and temperature stresses to prevent cracking. In continuous spans where negative bending occurs over the supports, sufficient tensile steel is added to take care of the calculated stresses. This is shown in Fig. 6.

Wide usefulness indicated

The advent and successful service of this type is a matter of more than incidental importance to structural engineers, generally. While making no commitment for the future, every indication points to the likelihood of this development bringing about modifications in bridge-type selection of very considerable extent in the tidewater area of Maryland. And, as the construction is improved and becomes adapted for a wider range of conditions, its influence will be a correspondingly greater factor in the shaping of our general bridge-construction policy and programs.

Features of the composite-type construction which appeal to the Maryland State Roads Commission are, aside from consideration of its low cost, an assembly of materials in such manner that permanent strength and rigidity is assured in service; maximum durability of the component materials is to be expected; freedom from need of replacement and of maintenance costs; suitable appearance; ample strength of curb and handrails; and, finally, ease and speed of construction at any season of the year.

The architectural treatment that is possible is readily noted in the accompanying illustrations.

The limitations of the construction to our conditions as we view them apply to such cases, usually in structures of major importance, where heavier substructures and longer span lengths are required than trestle-type construction affords. Even in this field, however, we expect that future development of the composite idea will produce types applicable to the situation in many instances. The use of the composite deck in connection with moderately long spans of steel-girder construction appears as a fruitful possibility, and preliminary studies of compound assemblies of the deck to form continuous or cantilever type spans, indicate interesting possibilities along this line. In the latter case, suitable arrangements

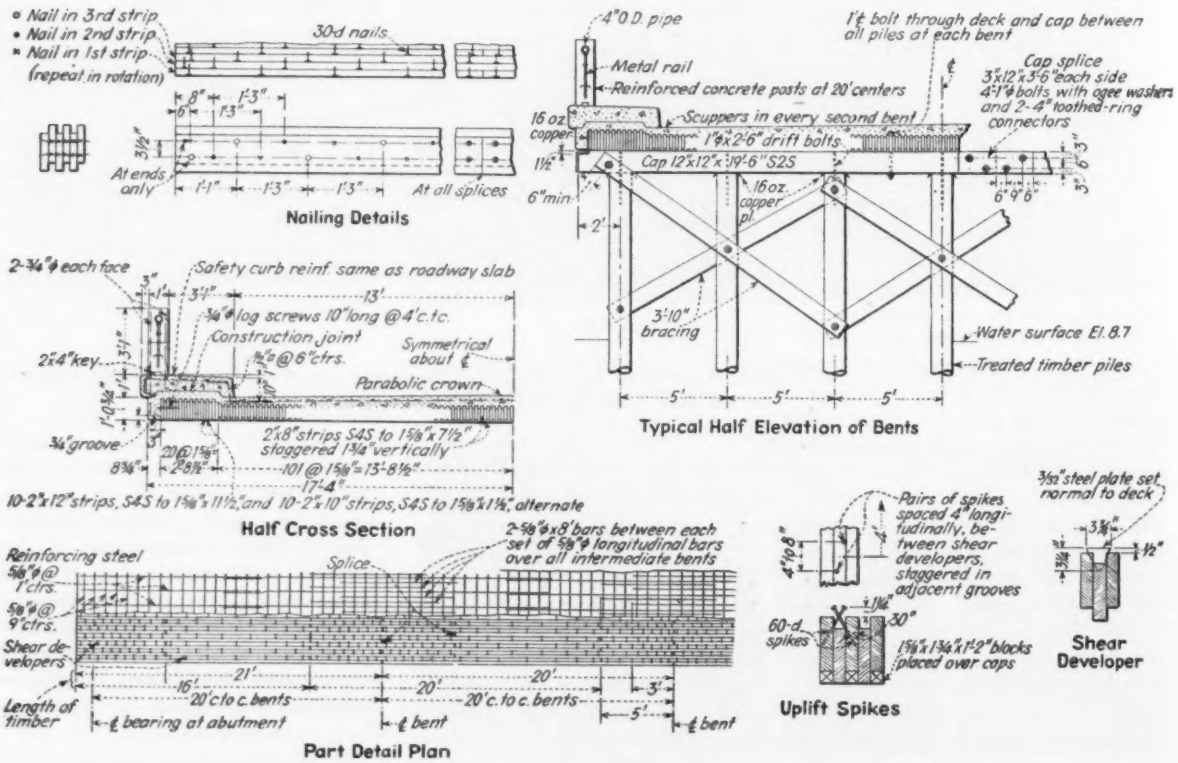


Fig. 6. Composite timber-concrete deck and a typical bent of the Tonytank Pond Bridge. This type of structure provides both durability and attractive appearance at a reasonable cost. These bridges are designed for H-20 loading.

structurally sound, should operate to produce new and pleasing architectural effects.

Composite bridges in Maryland

During the summer of 1937 the Maryland State Roads Commission became interested in the composite construction and investigated its reputed merits. The State Highway Department of Delaware had constructed a typical structure of this kind near Smyrna, Del., in 1936. Claims of the proponents of the construction and statements of those who had constructed bridges of this type elsewhere were checked carefully against the actual behavior of the Smyrna bridge in service; its construction details were studied and its cost items analyzed, and other questions pertinent to the case canvassed, including that of the durability of the treated timber installed under such conditions. As a result, the State Roads Commission designed and constructed a 5-span bridge of this type, with a 30-ft. wide roadway, over Faulkner's Branch, at Federalsburg on the Eastern Shore, during the 1937 season, built at a cost of $3.25 per sq.ft. Since 1937 the commission has completed a total of nine composite structures and has prepared plans for more bridges of this type.

All these bridges are designed for the H-20 loading of the American Association of State Highway Officials and, in general, the same span lengths and the same timber makeups have been employed as in other typical composite bridges designed for the H-15 loadings. Owing to the heavier wheel concentration of the H-20 loading, Maryland designs employ a correspondingly greater number of shear developers and a slightly thicker concrete flange or surface to keep within generally recognized working stresses for the several materials of the construction under the assumed loads. All shear developers are specified to be galvanized, as is all hardware, and in Maryland, we require shear developers to be cut in the form of a trapezoid (see Fig. 6) instead of a triangle which affords, in our opinion, a more substantial embedment of the member in the depressed timber of each groove. Otherwise, Maryland designs are similar to designs used elsewhere.

Timber in these composite decks is treated with 8 to 10 lb. per cu.ft. of Grade No. 1 creosote oil, but in some cases a salt treatment of ¾ lb. per cu.ft. of chromated zinc chloride has been used. This salt is both a preservative and fire retardant; it also makes the timber easier to handle in the field operations.

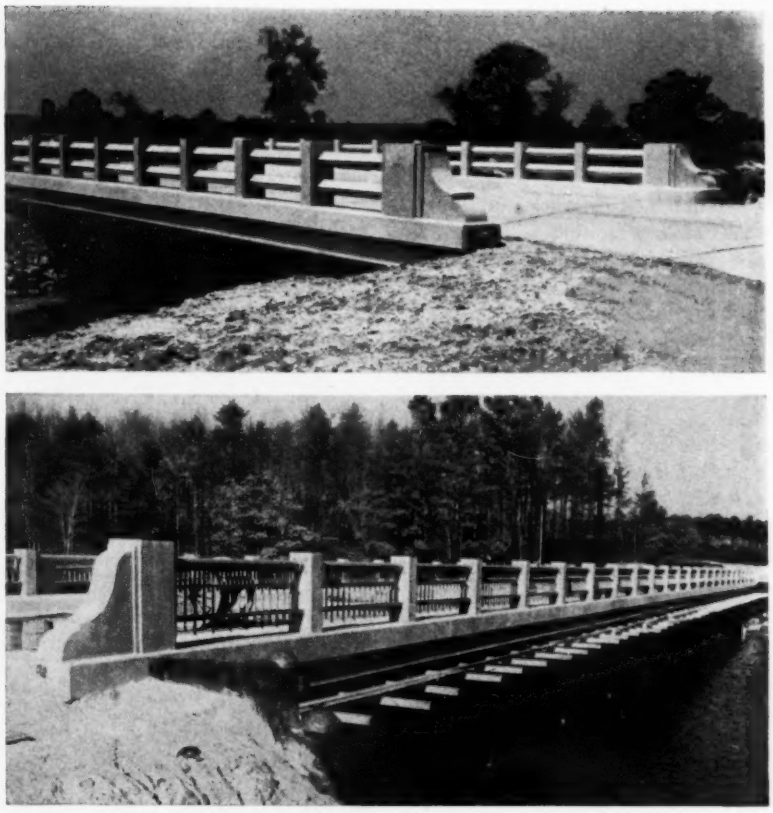


Fig. 7. Pleasing appearance is a characteristic of the composite timber-concrete bridges. The Unicorn Branch Bridge at the top shows one of the variations in reinforced-concrete rails used on these structures. Below is the Tonytank Pond Bridge, details of which are shown in Fig. 6.

Early in the development of the composite-type bridges, loading tests were conducted and since then design assumptions as to distribution of load and of bending moment in continuous span bridges have been based largely on these tests, deck slabs being proportioned accordingly. It is believed that the practice thus developed is on the whole conservative, and, as a matter of fact, it has been employed in the preparation of plans for composite bridges in Maryland. Nevertheless, a review of these field tests, made as they were with improvised equipment and in a manner not well adapted to scientific analysis, left much to be desired in the way of developing sound principles on which good design might be based.

For example, where measurements of extremely small values are involved, even minor variations easily can introduce errors of relatively great magnitude. Moreover, the manner of loading in the tests referred to was such as to render it impossible to segregate the effect of the separate wheel loads and thus yield a formula by which the effect of any number of loads on a transverse element of the span could be determined for a given critical point. Again, since no measurements of deflections were made in spans adjacent to a loaded span, determination of moment distribution necessarily could be considered as roughly approximate only.

Under the circumstances, it was felt that more accurate information in respect to design assumptions was required in order to avoid wasteful procedure in future work. In consequence, it was decided to conduct a loading test on one of Maryland's composite bridges, a two-span structure completed in 1938.

This structure has a total length of 43 ft., span lengths being 21 ft. center to center of supports. The clear roadway width is 56 ft. and the two side-

walks each are 8 ft. wide. The structure is built on a skew of 23 deg. Selection of this bridge for the test was made largely because of the wide roadway which would afford results unaffected by the action of curbs. It was also evident that results previously obtained from tests on interior spans of long continuous bridges are not properly applicable to two-span structures, a very common type of highway bridge.

Discussion of the very interesting facts disclosed by these tests cannot be made in this article. However, it might be said that for the two-span structure we found, for the positive moment, 82 percent of simple span moment, and for negative moment, 37 percent of simple span moment. This compares with values of 67 and 50 percent, respectively, that have been used for interior spans of continuous bridges. The discrepancy between these values indicates the validity of the comment made above in respect to two-span versus longer continuous span bridges and this should be taken into account in the case of all end spans of any continuous multiple-span bridge. For design purposes the following is suggested:

DISTRIBUTION OF LIVE LOAD BENDING MOMENTS

	Percentage of simple span moment	
	Positive	Negative
All end spans.*.....	85	..
2-span bridges.....	85	40
Interior spans of multiple-span bridges..	70	50

Deflection ratios for the test wheel-loads indicated a ratio of 1/1,850 and reducing the test wheel-loads to correspond to the H-20 specifications, this ratio becomes 1/1,560. For interior spans of three or more span bridges, it is likely that the ratio would become very nearly 1/2,000.

Possibilities of laminated construction

In view of the fact that deflection ratios of 1/1,000 are considered extremely good for modern continuous bridges and, indeed, are rarely attained, the fact that composite bridge decks of the laminated type behave as they do in respect to deflection is nothing else than highly remarkable. Certainly, this development of laminated composite construction sets a new standard for behavior of bridges in this respect.

Vibrations which are set up by dynamic forces created by a moving vehicle or other type of live load need to be considered in connection with deflection ratios. Elasticity of the construction materials affects the period of vibration, which is well defined when component members have equal elastic properties. In this case we have two materials intimately bound together and acting in unity, yet of greatly differing elasticity; again in the wood portion of the composite member we have a wide variation in modulus of elasticity between the individual pieces with the overall result that vibration periods do not synchronize and the harmonic waves are broken up and absorbed. One has only to observe the behavior of these decks under moving loads to appreciate the utter freedom from vibration that they enjoy.

It is the author's belief that composite timber-concrete construction is the outstanding development in the field of wood utilization for engineering construction of the present time. It seems likely that its application to the simple structures so far employed is but the merest beginning of a greatly extended field of usefulness, not only in bridge structures but elsewhere in various types of construction. A great deal remains to be done by way of research and test to determine facts pertinent to its use in different forms and its application to heavier and longer span bridges.

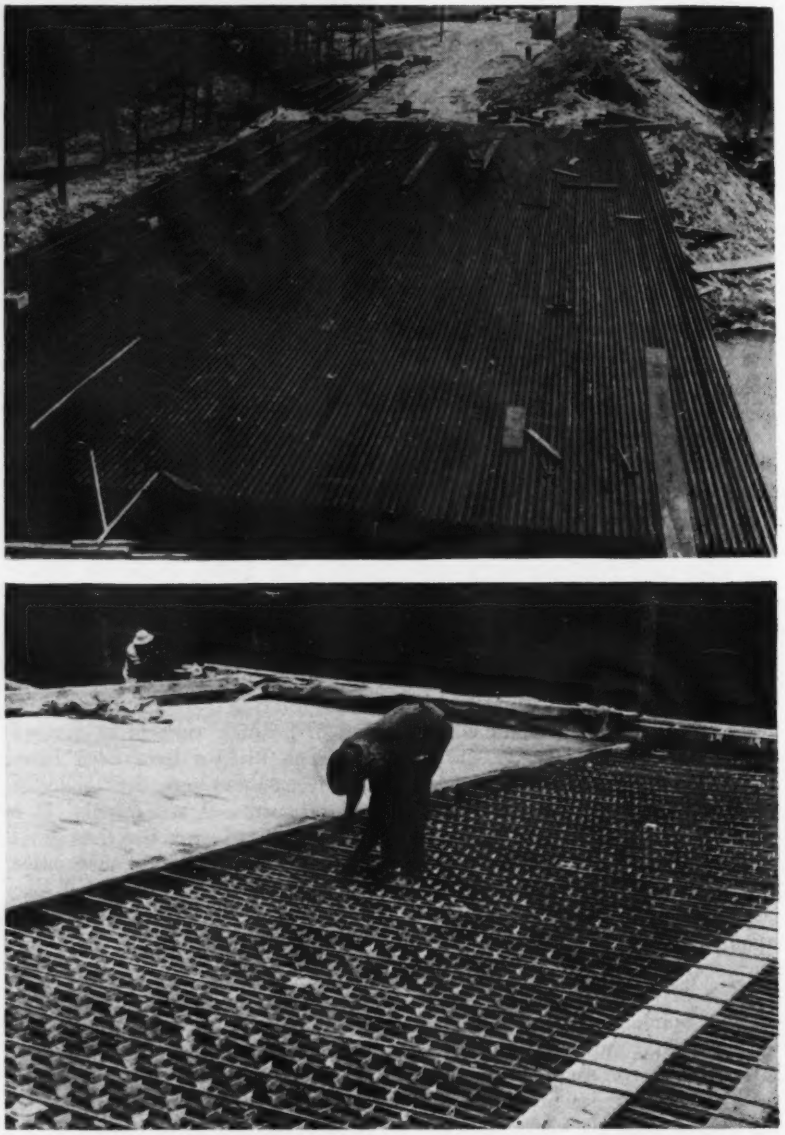


Fig. 8. Two stages in construction of composite decks. Above, the laminated timber ready to receive the concrete; below, driving uplift spikes after the shear connectors have been set.

Fig. 1. Use of large pneumatic tires on vehicles working on highway fills aids materially in obtaining proper compaction.

Stabilization of Highway Embankments

Prepared by the Division of Tests,
Public Roads Administration, Federal Works Agency,
Washington, D. C.

***Contents in Brief**—Experience in the construction of moderately high embankments for highways has shown that most soils can be used for that purpose if the moisture content is carefully controlled and the correct density for the type of soil used is obtained. Settlement of high fills can be kept within safe limits by refinements in determination of the soil characteristics and in soil compaction if the embankment slopes are adjusted to the characteristics of the material. Blanket courses of high-grade soils are required on some fills to give better load-carrying capacity or to prevent undesirable changes in moisture content of the embankment.*

THE PRIME OBJECTIVE of soil research in relation to the construction of satisfactory highways remains unchanged. It consists of making the total road structure — surface, base course and foundation soil combined — adequately resistant to the stresses produced by traffic and to the detrimental effects of climatic influences.

Compaction alone is generally sufficient to make most soils suitable for use in stable embankments. Base courses, on the other hand, may require that compaction be supplemented by admixtures of other soils, sand or coarse aggregates or both, or by admixtures of bituminous oils, cement or salts. Only in the case of a few soils can satisfactory base courses be made from soil in its natural state.

Recent progress in soil compaction includes a better knowledge of the use of the test data and the development of suitable methods of control during construction. In the design of sand-clay and soil-aggregate mixtures for use in base courses, the outstanding feature is the emphasis given by the rapidly accumulating data to the importance of the plasticity index requirement of the standard specifications for stabilized base courses of American Association of State Highway Officials.

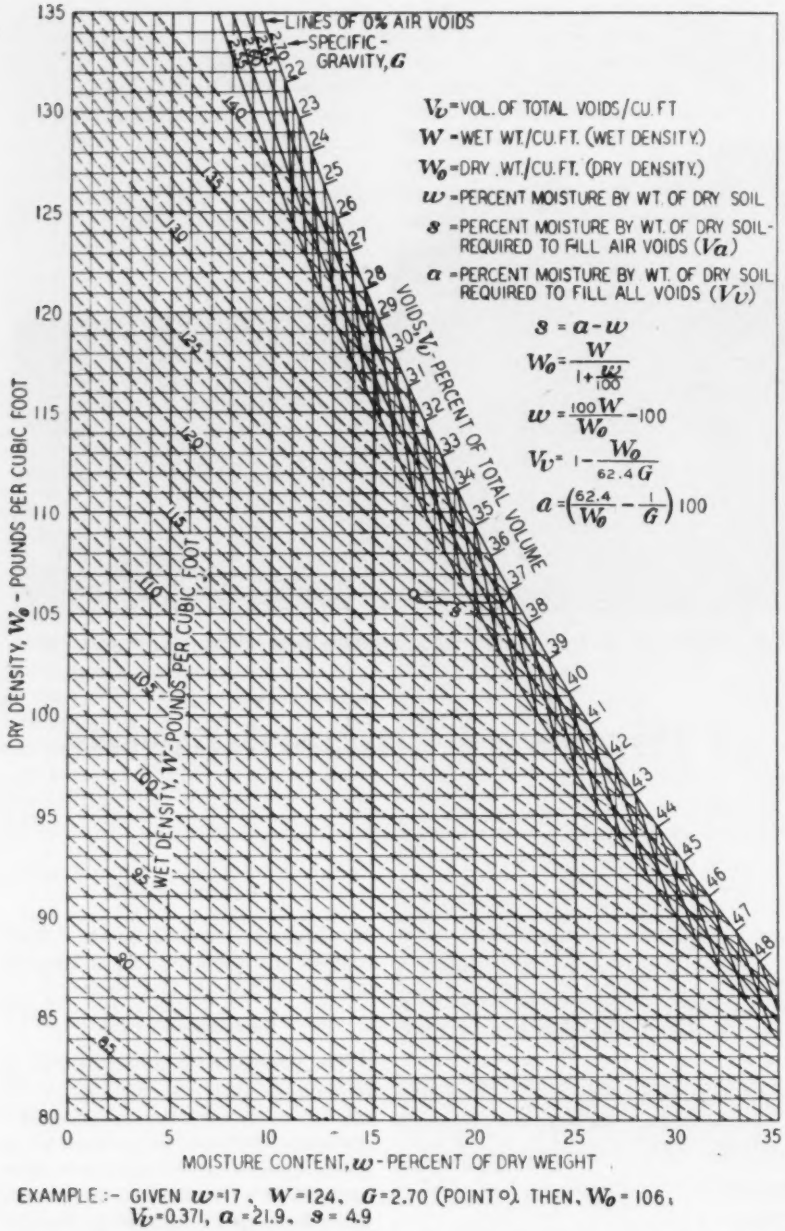
This article relates to the application of soil research to construction of highway embankments. Base courses and surfacing are treated in another article in this issue.

Compaction of soil

The theories of soil compaction in relation to moisture content of the soil are too widely known to require repetition. Suffice it to say that, for a given amount of compactive effort applied to a given soil, there is a moisture content, known as the optimum, at which the soil will have the greatest weight per cubic foot. On this basis a method which utilizes one specified compactive effort has been given standard status by the American Association of State Highway Officials.

Each soil has its own standard optimum moisture content only when the standard compactive effort is used, and any change in compactive effort produces a change in the optimum moisture content and the resultant weight per cubic foot.

The standard optimum moisture content and the standard maximum density provide the information essential to the control of the con-



EXAMPLE:- GIVEN w=17, W=124, G=2.70 (POINT ○) THEN, W_o = 106, V_v=0.371, a = 21.9, s = 4.9

Fig. 2. Chart of the relations of density to moisture content and voids in soil.

struction of embankments and subgrades. It has been customary to assume that soils placed in these conditions of moisture and density will have adequate stability. This assumption is valid only if, subsequent to construction, the compacted soils will not undergo change of density due to swell or consolidation; and secondly, if the soil at the standard maximum density has sufficient shear strength to satisfy the design requirements of the embankment cross section.

This assumption has been found to be true only in part. Experience has shown that some soils compacted to standard maximum density, other than those of the A-1, A-2 and A-3 groups of the Public Roads Administration classification, are likely to swell when subjected to the influences of seasonal changes which produce fluctuations in moisture content. (The A-1, A-2 and A-3 soil groups are the three better groups of soils for road work.) On the other hand, investigations of the warping of rigid pavements by the Highway Research Board, supplemented by swell tests made under laboratory conditions, indicate that soils compacted with moisture contents several percent above the optimum are not likely to swell detrimentally. The exact amount of moisture in excess of the optimum required to prevent the swell of subgrade soils can be determined by means of a swell test in the laboratory. Such a test under the designation of T 101-42 is now being considered for advancement to standard status by the A.A.S.H.O.

Work with this test by the Public Roads Administration and others indicates that, with few exceptions, an excess of about two percent of moisture above the optimum is sufficient to eliminate swell. Therefore, it is now considered good practice to place subgrades and the top layers of embankments (1 to 4 ft., depending on conditions) at a moisture content about two percent above optimum.

General experience, supplemented by consolidation and direct shear tests, indicates that compaction to standard density at standard optimum moisture content is amply adequate for the remainder of embankments up to 50 ft. in height, comprised of other than A-1, A-2 or A-3 soils, and which have standard densities not less than 90 lb. per cu. ft.; and for the entire embankment of any height comprised of A-1, A-2 or A-3 materials.

This conclusion is recognized in "Specifications for Materials for Embankments and Subgrade, Designation M 57-42," now also being considered by the A.A.S.H.O.

Construction of high fills

For embankments higher than 50 ft., it is advisable to make consolidation and direct shear tests on the compacted samples. The test data may indicate that soil compacted to standard maximum density is suitable or they may indicate that the soil in the lower part of a very high embankment will be consolidated ultimately to a density greater than the standard maximum. Under such conditions, it is advisable to place the soil in the lower part of the embankment at the higher density.

As an illustration, assume that a soil with a specific gravity, $G = 2.70$, has, according to the A.A.S.H.O. standard method, an optimum moisture content, $w = 17$ percent, and a wet density, $W = 124$ lb. per cu. ft.

Now refer to the chart, Fig. 2, which shows relations between the

values of w, W, W_o and G of compacted soils. According to this chart, the soil in question will have a dry density, $W_o = 106$ lb. per cu. ft.; a volume of voids, $V_v = 0.371$ or 37.1 percent; and an amount of moisture required to fill the air voids, $S =$ about 5 percent.

Now assume that the consolidation test shows that the weight of superimposed earth in the finished embankment will ultimately reduce the voids to 35 percent. This corresponds to a dry density of 109.3 lb. per cu. ft. and, with the air voids remaining about constant, to a wet density of approximately 126 lb. per cu.ft. To prevent settlement, the lower portion of the fill must be compacted to this wet density and this can best be accomplished by using increased compactive effort at a moisture content of about 15 percent rather than the 17 percent shown by the standard test.

Let it be further assumed, in accordance with the preceeding discussion, that the top part of the embankment is to be placed at a moisture content two percent above the opti-

Fig. 4. Careful control of compaction in high fills insures a stable bank free from settlement. This work was on the Altamont Pass highway in California.

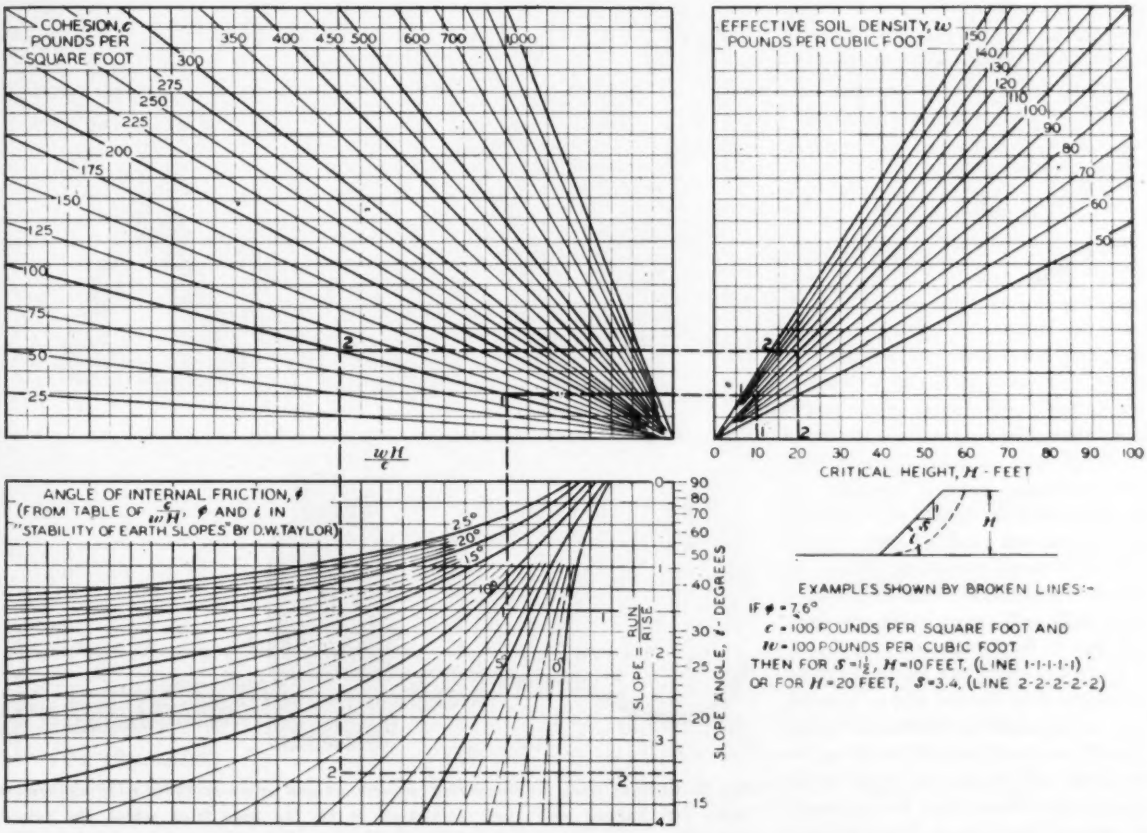

COHESION, c POUNDS PER SQUARE FOOT
EFFECTIVE SOIL DENSITY, w POUNDS PER CUBIC FOOT
CRITICAL HEIGHT, H - FEET
ANGLE OF INTERNAL FRICTION, ϕ
(FROM TABLE OF c/wH, ϕ AND i IN "STABILITY OF EARTH SLOPES" BY D.W. TAYLOR)
SLOPE = RUN/RISE
SLOPE ANGLE, i - DEGREES
EXAMPLES SHOWN BY BROKEN LINES:-
IF ϕ = 7.6°
c = 100 POUNDS PER SQUARE FOOT AND
w = 100 POUNDS PER CUBIC FOOT
THEN FOR S = 1½, H = 10 FEET, (LINE 1-1-1-1-1)
OR FOR H = 20 FEET, S = 3.4, (LINE 2-2-2-2-2)

Fig. 3. Chart for determination of the correct slope of embankment sides for varying conditions of density, cohesion and angle of internal friction of the soil from which the embankment is being constructed.

mum. This makes the required value of $w = 19$ percent. In this case, the chart, Fig. 2, shows that, with the air voids of about 5 percent, the maximum wet density that can be obtained will be about 122 lb. per cu. ft.

Now consider the use of the shear test data. Let it be assumed that an embankment 80 ft. high with side slopes, $s = 2$, is to be constructed of an A-4 soil, which at a maximum density of 110 lb. per cu. ft. has a usable value of cohesion, c, of 400 lb. per sq. ft., and a usable value of the angle of internal friction, ϕ, of 15 deg.

Fig. 3 provides a quick means of applying the shear test data in checking the design of the cross section. (Construction of the chart and its use were fully described in PUBLIC ROADS, October 1940.) Beginning with the upper right-hand chart, follow the critical height vertical, $H = 80$, to its intersection with the soil density line, $w = 110$ lb. per cu. ft. From this intersection follow a horizontal into the upper left-hand chart to the line, $c = 400$, then follow a vertical into the lower left chart to the curve, $\phi = 15$ deg. A horizontal from this point indicates a safe slope of $1\frac{3}{4}$ to 1. With respect to shear strength, therefore, the soil compacted to the standard density satisfies the designed cross-section requirements. Otherwise, flatter slopes, greater density or both would be required in the embankment.

Blanket courses

Some soils compacted to maximum density at the optimum moisture content or at the moisture content necessary for minimum volume change may not have sufficient bearing capacity to support pavements carrying heavy traffic. Also there is the possibility that soils originally compacted at the proper moisture content may lose moisture during periods of drought with a resultant shrinkage and subsequent swell of such magnitude as to cause pavement distress or failure. In addition, in cold climates some soils will cause extensive damage due to frost heave.

To insure adequate bearing capacity where it is needed and to prevent loss of moisture in expansive soils, blanket courses from 12 to 24 in. in thickness are frequently used, while greater thicknesses may be necessary to prevent frost heave. These blanket courses may consist of A-1, A-2 or A-3 soils or other available non-expansive materials such as stone screenings or quarry wastes.

A study in advance of construction of the soils available on a project may disclose materials suitable for use in blanket courses. In such cases it will frequently be possible to plan the construction procedure so that such materials may be utilized with little increase in the cost of the work. Such selection from locally available borrow may eliminate the necessity of obtaining suitable materials from other sources at higher cost. However, if the need for a blanket course is indicated, and suitable materials are not locally available, the purchase elsewhere of materials that will be suitable is advisable.

Compaction of soil furnishes the best means yet developed for producing stable embankments. However, there is a growing tendency in the use of compaction test data to consider also the results furnished by other tests of the soil such as those for consolidation, swell and shear strength.

The practice of selecting materials during grading operations for use in the construction of blanket courses is fully justified from both the engineering and economic standpoints. Reservations of the best available soils for use in blanket courses on the upper portion of embankments and subgrades provides a means of utilizing to the best advantage the materials which nature has provided.

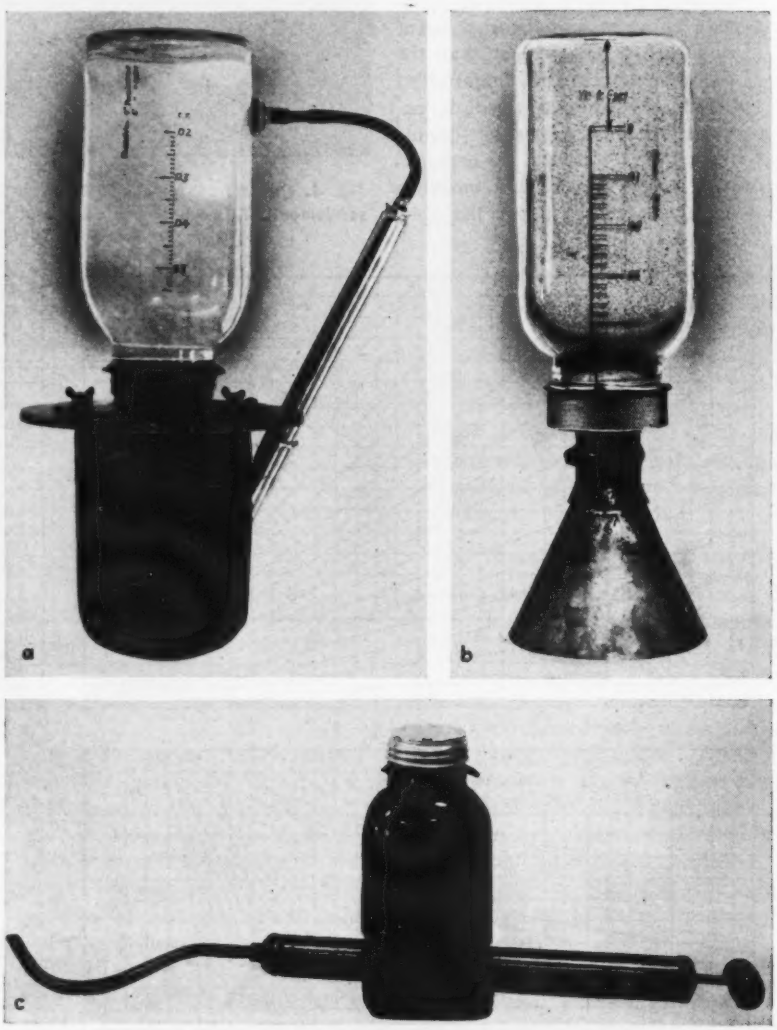
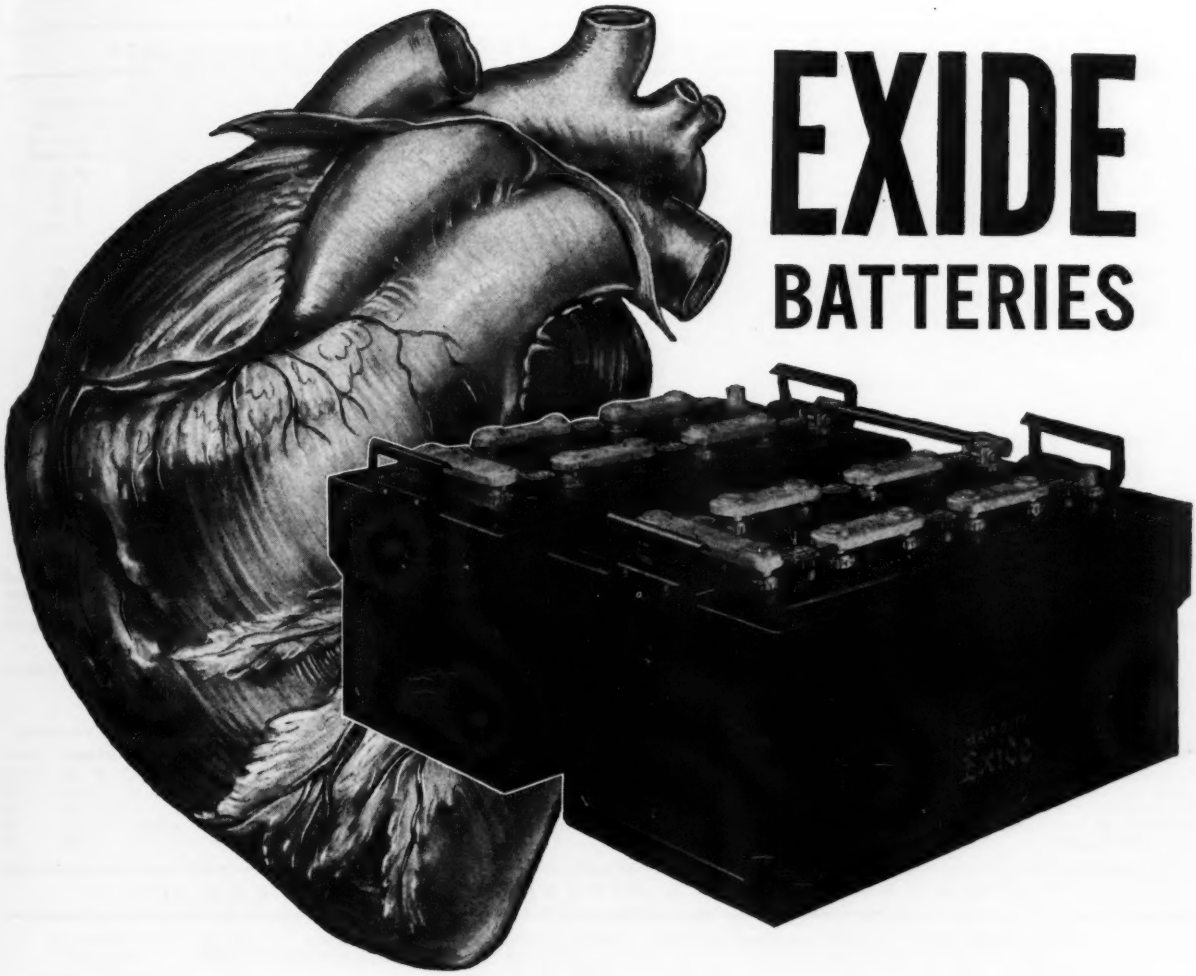


Fig. 5. Devices used in measuring volume of soil samples in density determinations: (a) Rubber sack that is inflated to fill the hole from which the sample was taken, the volume being read on the jar; (b) cone and jar used in filling the hole with a known volume of sand; (c) pump and jar used to fill hole with known volume of heavy oil.

To start the heartbeat of a Diesel....



EXIDE BATTERIES

IT takes a husky battery to make the life-blood of action course through a Diesel engine. It takes a dependable battery to crank a cold Diesel in sub-freezing weather.

Yet whatever the weather, whatever the Diesel, there's an Exide Battery to do the job right.

Exide Batteries pour out their tremendous reserve power at high voltage . . . for faster cranking. Exide Batteries have proven their worth in locomotives, industrial plants, construction camps, ships . . . in fact, wherever Diesel engines are used. There's an Exide Battery for every size and type of Diesel. No job is too big for an Exide.

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DIESEL ENGINES

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The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

FEBRUARY LUMBER prices continued active, with increases being reported in Cincinnati, Dallas, Kansas City, Minneapolis and St. Louis. Southern pine prices are up $1.00 to $3.00 per M ft. b.m., in Cincinnati; 50c. higher in Dallas; $2.00 to $3.50 higher in St. Louis; up $1.00 on 2x10-in. in Chicago; and up $2.00 on 2x8-in., and 75c. on 2x10-in. in New Orleans. Douglas fir is $2.00 to $4.00 higher in Minneapolis; and minor increases on some sizes are reported in Chicago and New Orleans. Pine timber climbed in Birmingham, and fir timber rose in Chicago, Cincinnati, Minneapolis, St. Louis, and Denver.

Quotations for portland cement in cloth bags in all cities is unchanged from a month ago; structural steel shapes and reinforcing steel are at January levels. Window glass discounts are reduced in Denver, New York, Philadelphia and St. Louis. White lead prices are up 50c.

The Birmingham bricklayers' rate is up 25c. per hour from the $1.50 formerly reported. Plasterers' wage is 12½c. per hour higher in Chicago.

Common building labor rate in Birmingham is now 65c., an increase of 5c. per hour; and common labor on heavy construction is now 55c., up 10c. per hour.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags *a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.73	$2.48	$2.43	$1.75	$1.85	$1.95	$1.75	$1.85	$1.55	$1.65	$7.90
Baltimore	2.46	2.21	2.01	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	7.25
Birmingham	2.50	2.25	....	1.75	1.75	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.40‡	1.40‡	1.00‡	1.40‡	1.40‡	....	....	7.25*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.50‡	1.50‡	....
Cincinnati	2.31	2.06	1.81	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.39	2.14	....	1.60*i*	1.60*i*	1.55*i*	2.05*i*	2.05*i*	1.70*i*	1.70*i*	7.30*i*
Dallas	2.52	2.27	2.07	1.75*p*	2.00*p*	1.25*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.08	2.88	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.39	2.14	1.94	1.50	1.60	1.28	1.65	1.65	1.65‡	1.65‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.25*m*
Los Angeles	2.80*u*	2.20*u*	....	1.20	1.20	1.15	1.20*f*	1.20*f*	....	....	6.35
Minneapolis	2.90	2.65	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.85*f*
Montreal	....	1.95*rs*	1.79*rs*	....	....	1.25‡*t*	.85‡*ct*	1.00‡*ct*	....	....	6.45*ls*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.55‡	2.30‡	....	1.50*de*	1.50*de*	.90*ds*	1.70*de*	1.80*de*	....	....	6.75
Philadelphia	2.31	2.07	1.87	1.55‡	1.65‡	1.15‡	1.90	1.90	1.10	1.10	8.20*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	8.25
St. Louis	2.80	2.52	....	1.50‡	1.50‡	1.25/1.50‡	1.25*h*	1.25*h*	.85*g*	.85*g*	8.00
San Francisco	....*w*	2.21	1.76	1.36	1.36	1.36	1.46	1.46	....	....	7.55
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days. *s* 8% sales tax included. *t* 8% sales tax not included. *u* Price withdrawn. *v* 20c. per bbl. discount; 20c. allowed for returnable cloth bag.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

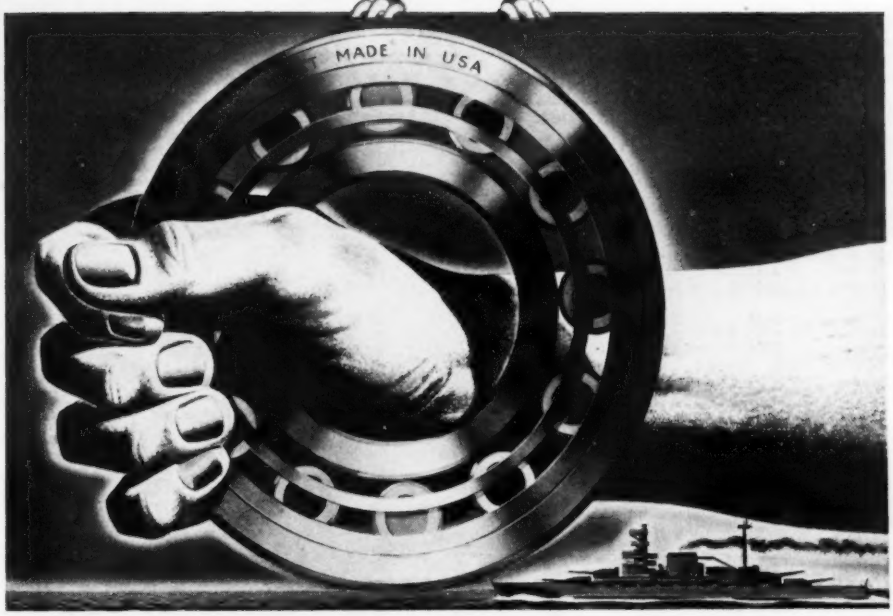
	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	$1.80	$1.75
Dallas, Tex. (Inc. 10c. tax)	1.85	1.80	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.75	1.70	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex (Plus 10c. tax in Tex.)	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala.	1.70	1.65	Montreal (8% sales tax incl.)	1.68	1.67

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3-4x8¼ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal., 80-300 penetration		Per ton		Per gal.	Per gal.	
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$18.40*e*	$24.62*e*	$0.0787*e*	$0.1309*e*	$0.0826*he*	$0.1348*h*	$0.0676*e*	$0.0826	$0.1348
Baltimore	145.00‡	45.00‡	2.90	14.00*	20.00*	.06*	.09*	.065*h*	.115*h*	.....	.....	.....
Birmingham	.....	32.00*j*	....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.065	.09	.12
Boston	85.00	50.00	3.50	14.00	20.00	.06	.09	.065*h*	.115*h*	.065	.09‡	.12‡
Chicago	150.00	49.00	2.00*d*	14.50	18.50	13.00*g*	17.00*g*	.065*h*	.11*h*	.055	.10	.13
Cincinnati	112.00	37.50	....	16.00	20.00	.08	.....	11.80	.....	.07	.....	.085
Cleveland	110.00	38.50	2.25	20.00	25.00	.095	.115	.105*h*	11.00	.07	.09	.10
Dallas	.....	36.00	....	13.25	20.30	.06	.103	16.00	24.80	.055	.05/.07	.07/.09
Denver	.....	27.50	....	....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	37.50	....	14.10*f*	19.00*f*	.061	.1025	14.10	18.60	.055	.0645	.098
Kansas City	.....	40.00	....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	....	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.87*d*	21.20*m*	27.70	.....	.126	.....	32.64	.....	.....	.....
Montreal	.....	.....	....	16.60*k*	24.25*k*	.116*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.135*k*	.188*k*
New Orleans	.....	.....	....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	.....	....	15.00*	21.00*	.06*	.09*	.065*h*	.115*h*	.....	.0725*	.....
Philadelphia	125.00	49.50	3.51	15.00*	22.00*	.06*	.12*	.07*h*	.13*h*	.06*	.07*	.13*
Pittsburgh	135.00	38.75	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	.....	37.00	....	15.00	20.00	14.00*g*	20.00*g*	.06*h*	.11*h*	.045	.09	.125
San Francisco	.....	70.00	....	9.50	18.00	9.50*g*	18.00*g*	10.00	17.50	9.50*g*	.0525	.1125
Seattle	.....	60.00*c*	....	17.90	25.85	.....	26.45*g*	12.50	.....	.....	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3¼x4x8¼ in. *d* 2½ in. 12-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in. *k* tax included. * December asphalt prices; none later available.

BUSY ON AMERICA'S ★ ★ ★ BIG JOB ★ ★ ★



Twenty-four hours a day—Hyatt is busy on the biggest job of our lifetime—helping to do our part in building for Victory.

Hyatt Roller Bearings are used in land, sea and air fighting equipment . . . as well as in the machinery which helps build it . . . and in the construction equipment so vitally important today. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey; Chicago, Detroit, Pittsburgh and San Francisco.

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ROLLER BEARINGS

QUIET

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ½-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.75	$2.55	.....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.75
Chicago	2.10	2.15	3.75	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.75
Pittsburgh	2.10	2.15	3.75	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.75
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	.....	.....	2.15	.....
Cleveland	2.10	2.15	3.75	2.55	.....	.....	.....	.....	.....	.....	.....	.....
Youngstown	.....	2.15	.....	.....	.....	.....	.....	.....	.....	3.00	.....	.....
Detroit	.....	2.25‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gulf ports	2.45*a*	2.50*a*	.....	.....	2.85*a*	.....	.....	.....	.....	.....	.....	.....
Pacific ports	2.75*a*	2.80*a*	.....	.....	2.95*a*	.....	.....	.....	.....	.....	2.30	.....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS* Per 100 lb., ¾ in., base price: 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd.. carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.06	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.70	2.90	2.75	.....	.10	29.00	30.00	1.70	1.27	.1611	3.00
Birmingham	2.10*a*	2.15	....	.02½	.10	.....	.....	1.80	1.34	.1701	....
Boston	3.85	3.51	3.36	$20 C.L.	.10	18.50	29.50	1.76	1.31	.1656	2.70
Chicago	2.10*a*	2.15	2.15	.03	.05	21.50	23.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51*cd*	2.51*cd*	.....	.05	19.50	21.50	1.66	1.25	.1566	....
Cleveland	2.10*a*	2.15	2.15	.02½	.10	19.50	21.50	1.66	1.25	.1566	....
Dallas	6.00	3.40	3.40	.....	.....	24.50	26.50	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	26.50	28.50	1.97	1.45	.1863	....
Detroit	3.65‡	2.34	2.24	.....	.10	22.00	24.00	1.68	1.26	.1584	2.66
Kansas City	4.17	2.61*cd*	2.61*cd*	.0	.05	19.50	23.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.25	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	25.00	27.00	1.80	1.34	.1701	2.73*d*
Montreal	3.90*i*	2.65*i*	2.55*i*	.....	.....	26.00*hi*	33.00*hi*	2.58*i*	3.22*i*	.264*i*	....
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.76*e*	2.76*e*	.....	.15	17.50	19.50	1.76	1.32	.1665	2.74
Philadelphia	3.65	....	....	.....	.....	19.50	21.50	1.71	1.28	.1611	2.71
Pittsburgh	2.10*a*	2.15	2.15	.02½	.10	23.00	26.50	1.59	1.20	.1503	2.40
St. Louis	3.69	2.39	2.39	.0	.05	28.00	34.00	1.69	1.27	.1602	2.70
San Francisco	4.70	2.65	2.50	.02½	.10	21.00	24.50	1.93	1.42	.1827	3.00
Seattle	2.75*e*	2.50*e*	.....	.....	.....	34.50	38.50	1.93	1.42	.1827	2.95*e*

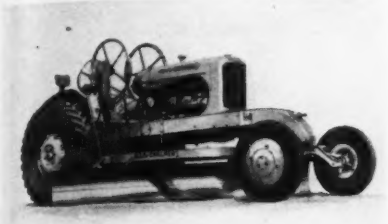
‡ Delivered. *a* Mill prices. *b* 5–15 tons add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 25c.; 1 to 5 tons add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills. *h* List price. *i* Plus Dominion and Province sales tax.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

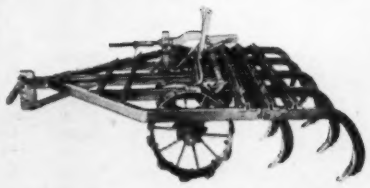
	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE: Per foot, std. 8 in., s.s.	delivered std. 12 in., s.s.	ASTM 24 in.,	C13–35 36 in.,	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h*: 1 to 3 in., Black %	Galv. %	Butt Weld 3½ to 6in.; Black %	Galv. %	Lap Weld
Atlanta	$49 40	$0.26*b*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.642	48.2	54.2	59.7	51.2	
Baltimore	52.80	.35	.60	2.50	7.10	150.00	200.00	.45	1.60	65.5	57.5	63.0	54.5	
Birmingham	45.00	.275	.495	1.95	5.50	100.00	220.00	.40	1.60	62.2	54.2	59.7	51.2	
Boston	55.00	.30	.58	1.95	....	128.00	.....	.65	....	64.1	56.1	61.6	53.1	
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.50	67.0	59.0	63.5	55.0	
Cincinnati	52.70	.231	.4455	1.80	5.125	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9	
Cleveland	54.24	.203	.3915	1.665	5.125	81.00	125.00	.38	1.60	67.8	59.8	65.3	56.8	
Dallas	58.20	.305	.549	2.25	5.00	90.00	110.00	.46	1.57	59.9	51.9	57.3	48.3	
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	....	....	58.4	50.4	55.7	47.2	
Detroit	54.24	.245	.4725	1.935	4.60	82.50	131.25	.35	1.50	66.3	58.3	63.8	55.3	
Kansas City	55.12	.315	.59	2.20	5.86	140.00	260.00	.45	1.60	62.9	54.9	60.0	51.5	
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6	
Minneapolis	59.00	.275†	.495†	1.98†	5.14†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2	
Montreal	60.00	.55	.90	3.68	5.95*e*	135.00‡*i*	260.00‡*i*	.48*m*	1.92*m*	....	.....	.....	....	
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3	
New York	52.20	.455	.8775	2.925	7.65	.....	.....	.50	1.20	64.9	56.8	62.4	53.9*i*	
Philadelphia	.....	.28	.54	2.30	6.75	120.00	200.00	.45	1.75	56.6	42.8	53.5	39.1	
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	57.5*i*	66.0*i*	54.5	
St. Louis	52.48	.28	.504	2.016	4.50	85.00	220.00	1.00*f*	1.75*k*	56.4	42.6	52.5	38.4	
San Francisco	58.00	.3625*d*	.6525*d*	2.61	6.52	115.50	192.50	.54	2.75	45.0	31.0	47.0	34.5	
Seattle	55.35	.375	.675	2.70	6.75	84.00	187.50	.45*f*	1.40*f*	.....	.....	.....	....	

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Based on existing freight rates; subject to rate change. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 16; 1½ in. black 38, galv. 18½; 2 in. black 37½, galv. 18. Lapweld—2½ in. to 3½ in. black 31½, galv. 14½ in.; 4½ in. to 8 in. black, 32½ galv. 17. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37. *l* Plus sales tax. *m* Tax included.

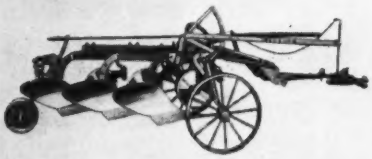
Heavy-Duty Tools That *"Stand the Gaff"* ON SOIL-CEMENT STABILIZATION



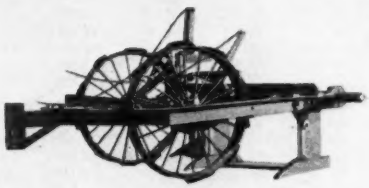
Model W-Speed Patrol for pulling-in edges, shaping and finishing. 10' blade, hand control.



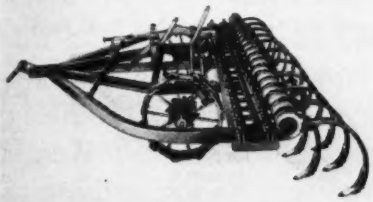
Extra heavy weight chisel for light ripping, mixing and pulverization. Depth control.



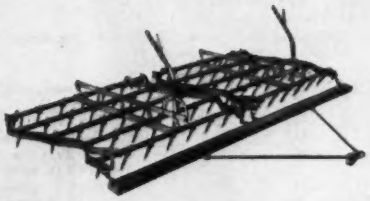
A-C high speed plows provide good mixing action and assure uniform sub-grade.



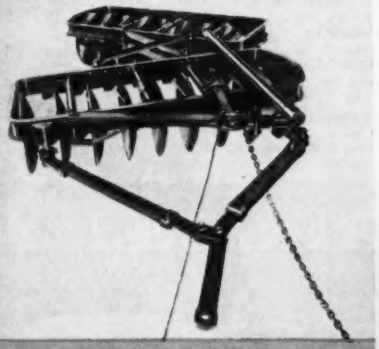
A-C sub-grader scarifies hard surfaced roads and maintains level sub-grade. Depth control.



Big, heavy-duty, soil-cement mixer with flexible coil shank teeth. Depth control.

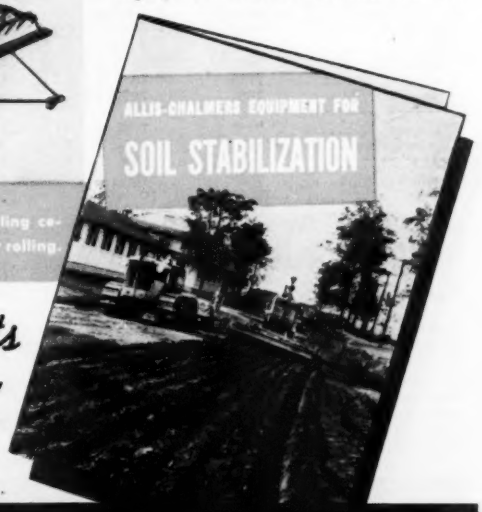


All-steel spike tooth harrow for leveling cement and producing surface mulch for rolling.



Extra heavy, offset disc harrow for pulverization and mixing. Easy turning, depth control.

Here are the kind of tools you need for soil-cement stabilization —long-wearing . . . tough . . . powerful . . . economical! Tools that have had years of service under the most difficult conditions on every type of soil. Tools that have proved they can handle any soil-cement mixture in stride —loam, clay, sand or gravel. A wide selection . . . from one source! One supplier . . . one service! Rippers, chisels, discs, scarifiers, plows and spike tooth harrows, for pulverizing, rooting and mixing . . . in addition to sheep foot tamping rollers, water spreaders, motor graders, wheel and crawler tractors for compacting, watering, grading and drawbar work! For complete information write for booklet: "Allis-Chalmers Equipment For Soil-Stabilization."



Get all the facts

Write for this new booklet . . . "Equipment For Soil-Stabilization."

ALLIS-CHALMERS

TRACTOR DIVISION · MILWAUKEE · U. S. A.

POWER IT DOESN'T COST . . . *it Pays!*

LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	2x12 Rgh	12x12 Rgh	¼"	¾"
Atlanta	**$27.00**	**$27.00**	**$26.00**	**$26.00**	**$27.00**	**$28.50**	**$43.00**	.....	.....	$60.00	$70.00	$17.75	$21.60
Baltimore	**39.00**	**40.00**	**40.00**	**38.00**	**38.00**	**40.00**	**56.00**	.....	.....	89.00	94.00	17.35*g*	21.15*g*
	44.00	*44.50*	*45.00*	*45.00*	*45.00*	*47.00*	*56.00*	*$59.00*	*$59.00*	.....	.....	.....	.....
Birmingham	**34.50**	**34.50**	**32.00**	**32.00**	**32.00**	**34.00**	**53.00**	**53.00**	**56.00**	.....	.....	16.25	19.85
[1]	37.50	37.50	37.00	37.00	37.00	43.00	65.00	.....	.....	67.50	70.00	.....	.....
Boston	**38.00**[3]	**38.00**[3]	**50.00**[3]	50.00	**75.00**[1]	**85.00**[1]	**95.00**[1]	.....	.....	95.00	105.00	17.35*g*	21.15*g*
	38.00	*38.00*	*50.00*	*50.00*	*60.00*	*60.00*	*75.00*	*75.00*	*75.00*	.....	.....	.....	.....
Chicago	**43.00**	**43.00**	**42.00**	**42.00**	**44.00**	**46.00**	**53.00**	.....	.....	90.00	100.00	13.80	16.80
	45.00	*45.00*	*44.00*	*44.00*	*46.00*	*48.00*	*50.00*	*55.00*	*55.00*	.....	.....	.....	.....
Cincinnati	**41.00**	**42.50**	**39.00**	**40.50**	**42.00**	**43.00**	**53.00**	.....	.....	65.00	68.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*55.50*	*55.50*	*55.50*	.....	.....	.....	.....
Cleveland	**42.00**	**42.00**	**40.00**	**42.00**	**44.00**	**47.00**	**53.00**	53.00	53.00	90.00	90.00	16.70	20.40
Dallas *e*	**39.50**	**40.50**	**39.50**	**38.00**	**38.50**	**39.50**	**53.00**	**53.00**	**53.00**	78.00	83.00	13.90	16.95
Denver ‡	54.00[4]	52.00[4]	55.00[4]	55.00[4]	55.00[4]	56.00[4]	59.00[4]	*73.00*	*79.00*	.....	.....	9.90	12.05
Detroit	**46.00**	**46.00**	**46.00**	**46.00**	**46.00**	**48.00**	**53.00**	.....	.....	53.00	61.50	16.25	19.85
	.....	.....	.....	.....	.....	*51.50*	*54.00*	*60.00*	*60.00*	.....	.....	.....	.....
Kansas City	**42.50**	**45.00**	**42.00**	**42.00**	**43.50**	**47.50**	**57.50**	.....	.....	70.00	75.00	12.25	14.95
	47.50	*47.50*	*47.50*	*47.50*	*47.50*	*47.50*	*60.00*	*70.00*	*70.00*	.....	.....	.....	.....
Los Angeles *a*	*55.00*	*55.00*	*55.00*	*55.00*	*51.00*	*51.00*	*57.00*	*66.00*	*66.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis ‡*b*	48.00[6]	48.00[6]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*52.00*	*52.00*	*52.00*	*51.00*	*51.00*	*52.00*	*58.00*	*60.00*	*60.00*	.....	.....	.....	.....
Montreal †[7]	*43.00*	*46.00*	*42.00*	*45.00*	*47.00*	*54.00*	.....	.....	.....	155.00	165.00	.....	.....
	42.25	*42.25*	*42.00*	*44.00*	*44.00*	*45.75*	*50.25*	*50.25*	*50.25*	.....	.....	.....	.....
New Orleans	**31.50**	**31.50**	**33.75**	**31.75**	**34.00**	**35.00**	**48.00**	.....	.....	69.00	69.00	13.90	16.95
	31.00	*31.00*	*33.00*	*31.00*	*34.00*	*32.00*	*53.00*	.....	.....	.....	.....	.....	.....
New York ‡	**45.00**	**46.00**	**44.00**	**45.00**	**46.00**	**47.00**	**57.00**	.....	.....	110.00*f*	120.00*f*	17.35*g*	21.15*g*
‡	.....	.....	*62.00*	*62.00*	*62.00*	*62.00*	*65.00*	*67.50*	*67.50*	.....	.....	.....	.....
Philadelphia	**37.00**	**38.00**	**36.00**	**37.00**	**38.00**	**40.00**	**42.00**	.....	.....	65.00	70.00	17.35*g*	21.15*g*
	47.00	*47.00*	*47.00*	*47.00*	*45.50*	*46.25*	*56.00*	*56.00*	*56.00*	.....	.....	.....	.....
Pittsburgh	**50.80**	**53.20**	**62.75**	**55.00**	**60.85**	**62.50**	**76.25**	.....	.....	.....	.....	17.00	20.70
	69.80	*68.10*	*68.10*	*65.50*	*65.80*	*66.65*	*88.75*	*88.75*	*88.75*	.....	.....	.....	.....
St. Louis ‡*c*	**45.00**	**46.00**	**44.50**	**42.50**	**43.50**	**45.00**	**58.00**	*67.50*	*67.50*	78.00	66.00	13.90	16.95
San Francisco *d*	*33.50*	*33.50*	*36.25*	*34.50*	*34.50*	*34.50*	*40.00*	*39.50*	*39.50*	.....	.....	7.30*g*	8.90*g*
Seattle	*35.00*	*35.00*	*35.00*	*35.00*	*35.00*	*35.00*	*40.00*	*40.00*	*40.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* F.o.b. cars San Francisco freight rate. *e* 10% discount taken off. *f* Up to 18 ft. † Plus sales tax.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ¾", $86.50; on ¾", $95.30; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness		EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*	
	A quality	B quality		
Atlanta	75%	75%	$0.15	
Baltimore	79%	80%	.15	
Birmingham	76%	76%	.105	
Boston	77%	78%	.15	
Chicago	79%	79%	.15	
Cincinnati	77%	77%	.15	
Cleveland	77%	77%	.19	
Dallas	78%	78%	.1625	
Denver	76%	76%	.155*e*	
Detroit	77-10%	77-10%	.15	
Kansas City	76-10%	76-10%	.155	
Los Angeles	86%*d*	88%*d*	.1575	
Minneapolis	76%	76%	.155	
Montreal	40-5%‡	47%‡	.1475†	
New Orleans	70%	75%	.16	
New York	80%	81%	.22*f*	
Philadelphia	76%	77%	.15	
Pittsburgh	79%	79%	.1225	
St. Louis	76-10%	76-10%	.155	
San Francisco	78%	80%	.155	
Seattle	75%	76%	.1575†	

Price of 60% Ammonia Gelatin is $0.01 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928. ‡ Plus sales tax.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me	$0.105	$0.13	$0.15
W. of Miss. to Rocky Mtn. States, Fla. and Maine	.11 -.1175	.135 -.1475	.155 -.1675
Rocky Mtn. States	.11 -.1225	.135 -.1525‡	.155 -.1725‡
Pacific N. W. States	.1075-.12	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1125	.135 -.1425	.155 -.1625

‡F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.23	$0.26
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.26	.28
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.27	.29
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.28	.29
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.31	.33
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.44
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.45	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.30	....	$1.80	....
	Pine	1.60	$2.40*a*	2.40	$3.40*a*
New York	S. L. Sap Pine	1.30/1.40	2.35	1.60	2.60
	Mixed Oak	1.55	2.35	2.00	2.95
Birmingham	White Oak	1.00	1.60*a*	1.30	2.25*a*
	Southern Pine	....	....	....	....
Chicago	Red Oak	....	2.05*a*	....	2.70*a*
	Southern Pine	....	....	....	....
Los Angeles	Douglas Fir	1.10	1.75*a*	1.60	2.50*a*
Philadelphia	Red Oak	....	....	....	3.00*a*
St. Louis*	White Oak	1.40	....	1.75	....
	Red Oak	1.40	1.85*a*	1.75	2.35*a*
	Sap Pine or Cypress	1.30	....	1.65	....
San Francisco	Douglas Fir	1.00*bcf*	....	....	2.45*caf*
Montreal	Birch or Maple	.85	....†	.95	....†

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle. *August prices; none later quoted. † Out of market.

CHEMICALS

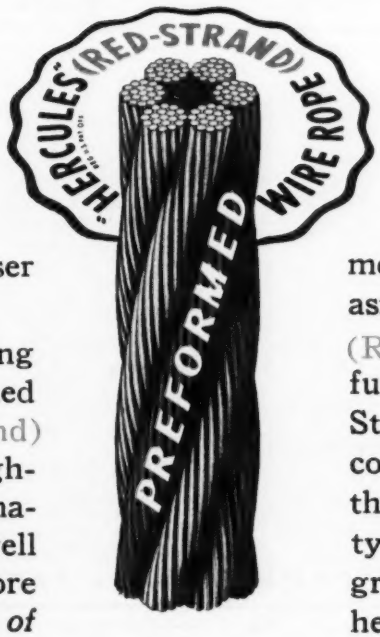
Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.25-3.10
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50-39.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb. *	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.15
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00-25.00
Sulphate of copper, in bbl., per 100-lb	5.15-5.50

Let's Keep Plenty of Them Flying...

EVERY ton of steel that can be diverted to the production of actual fighting instruments—planes, tanks, ships, guns—brings us closer to the day of Victory.

You can save steel by using longer - lasting Preformed "HERCULES" (Red-Strand) Wire Rope . . . a rope of highest quality not only as to material, but fabrication as well . . . a rope that delivers more *hours of work per pound of steel.*



Add to this saving by selecting your wire rope of the specific size, type, grade and construction that best meets *your* requirements. Inasmuch as "HERCULES" (Red-Strand) Wire Rope is furnished in both Round Strand and Flattened Strand constructions, as well as in the Standard and Preformed types, there is, in this one grade, a *right* rope for every heavy-duty purpose.

In order to help all wire rope users obtain maximum service from their wire rope, we publish an illustrated booklet "Practical Information on the Use and Care of Wire Rope". We would be glad to send a complimentary copy to anyone interested.

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WIRE ROPE MAKERS — ESTABLISHED 1857

5909 KENNERLY AVENUE — ST. LOUIS, MISSOURI, U. S. A.

NEW YORK . . . 90 West Street
CHICAGO . . . 810 W. Washington Blvd.
DENVER . . . 1554 Wazee Street
SAN FRANCISCO . . . 520 Fourth Street
PORTLAND . . . 914 N. W. 14th Avenue
SEATTLE . . . 3410 First Avenue South

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized or lump
Atlanta	$100.00	$110.00	$195.00	$230.00	$240.00	$240.00	$13.50	$18.00	$26.50	$17.00	$17.00
Baltimore	80.00	85.00	160.00	190.00	255.00	315.00	14.00*k*	17.00*k*	18.00	12.00	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	14.50	17.00	18.11	13.64	2.25*o*
Boston	88.40*u*	94.30*u*	176.90*u*	200.40	260.90	325.00	18.00*i*	21.00*i*	21.00	15.00	16.00
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	12.00	14.00	16.40	14.40	12.20
Cincinnati	65.55	69.90	131.20	148.70	210.35	240.45	17.50	17.50	15.40	12.90	.....
Cleveland	60.00	64.00	120.00	144.00	193.00	221.00	17.00	17.00	14.50*j*	13.25*j*	3.00*jm*
Dallas	52.00	54.00	100.00	135.00	200.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	94.40	152.70	178.20	212.00	227.90	13.50	17.00	30.00*j*	19.00*j*	30.00*j*
Detroit	74.50	81.60	153.00	194.00	253.00	289.00*e*	17.50	18.00	16.50	13.90	14.90
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	16.00	24.00	19.10	12.80	10.70
Los Angeles	73.50*tr*	89.50*tr*	128.00*ctr*	210.00*tr*	368.00*tr*	460.00*tr*	13.50	15.00	16.50	17.50	17.50
Minneapolis	81.00*b*	86.40*b*	146.90*b*	.....	177.00*b*	246.00*b*	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*au*	77.50*au*	142.50*au*	76.00*atu*	165.80*au*	248.70*u*	22.00*tu*	27.10*tu*	23.50*u*	17.00*u*	12.00*u*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	78.40	83.60	115.00*c*	193.30*h*	238.80*h*	295.60*h*	13.00	.....	20.00	14.00	17.00
Philadelphia	80.50	85.90	116.10	193.00	238.80	295.60	17.00*s*	20.00*s*	15.50*g*	10.05*g*	12.05*g*
Pittsburgh	62.35	66.55	124 75	140.25	173 25	198.00	17.50	19.50	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	170.00	187.00	220.00	17.00	18.00	22.00	18.00	18.00
San Francisco	84.00	94.50	225.00	.....	.....	.....	17.50	22.00	20.00	20.00	16.40
Seattle	105.00	115.00	210.00	.....	.....	.....	18.00*f*	22.00*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c. per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12. *u* Plus 8% sales tax.

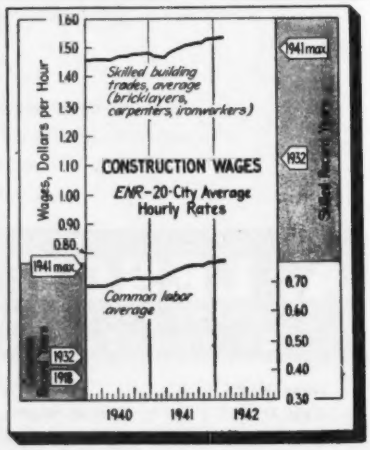
PAINT, ROOFING—F.O.B. CARLOAD LOTS

	RED LEAD Per 100 lb. in. 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85-90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$10.25	$14.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	10.00	13.75	1.95	2.90	2.50	2.10	2.50	2.50	.35	30.00
Birmingham	10.25	14.125	2.35	3.50*r*	1.85	2.04	1.97	1.97	.32	28.35
Boston	10.00	13.75	2.80‡	3.75‡	2.50‡	1.90‡	1.85*h*‡	1.85*h*‡	.50‡	20.00‡
Chicago	10.00	13.75	2.11	2.63	1.72	1.55*h*/	1.50*h*/	1.50*h*/	.26/	22.00/
Cincinnati	10.00	13.75	1.70	2.90	1.60	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	10.00	13.75	2.30	2.90	1.80	1.93	1.83*h*	1.83*h*	.40	25.00
Dallas	10.00	14.50	1.88	2.11*n*	....	2.30*h*	2.25*h*	2.45*h*	.35	39.00
Denver	10.50	14.25	1.65	2.60	.27*i*	2.45	3.15	3.15	.35	28.00
Detroit	10.00	13.75	1.75	3.00	1.60	2.40	2.50	2.50	.35	21.00
Kansas City	10.00	13.875	2.39*g*	2.55*gr*	2.16*gn*	2.10	2.30	2.30	.28	27.50
Los Angeles	10.25	14.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	10.00	13.875	....	....	....	1.75*i*	1.66*h*/*i*	1.66*h*/*i*	.29	21.00
Montreal	9.25	11.07	2.40*p*	2.97*p*	2.51*p*	2.85	2.58	2.01	.63	1.85*h*
New York	10.00	13.75	2.05	2.55	1.64	1.66	1.58*h*	1.58*h*	.26	25.00
Philadelphia	10.00	13.75	....	....	....	1.75	1.66	1.66	.29	23.00
Pittsburgh	10.00	13.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	10.00	13.75	1.90/2.00	2.60/2.80	1.60/2.00	1.92	1.91	1.91	.32	23.00
San Francisco	10.25	14.00	1.80	2.75*n*	1.10/2.00	1.89	2.66	2.66	.33	19.50
Seattle	10.25	14.25	1.80	2.60	....	2.12	1.45*h*	1.75	.35	24.15*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb. *m* Per bbl. *n* May price, no later quotation available. *p* Plus 8% sales tax *r* Not available.

SKILLED AND COMMON WAGE RATES—PER HOUR

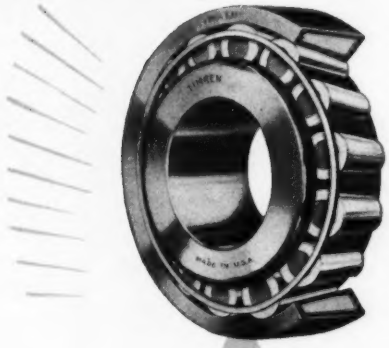
	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.375	$1.00	$1.375	$1.00/1.25	$1.25	$0.40	$0.50
Baltimore	1.625	1.375	1.65	1.65	1.50	.70	.70
Birmingham	1.75	1.125	1.50	1.50	1.50	.65	.55
Boston	1.50	1.25	1.50	1.625	1.625	.85	.85
Chicago	1.70	1.625	1.70	1.70	1.825	1.025	1.025
Cincinnati	1.625	1.50	1.55	1.325/1.525	1.625	.75	.75
Cleveland	1.75	1.50	1.75	1.75	1.75	1.00	1.00
Dallas	1.50	1.00	1.25	1.00	1.50	.50/.625	.50/.625
Denver	1.65*b*	1.43*b*	1.43*b*	1.43*b*	1. 51*b*	.718*b*	.718*b*
Detroit	1.60	1.40	1.75	1.625	1.675	.80	.80
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.50	1.175	1.50	1.50	1.667	.75	.75
Minneapolis	1.50	1.25	1.50	1.40	1.50*e*	.90	.90
New Orleans	1.50	1.25	1.50	1.375	1.375	.55	.55
New York	2.00*b*	1.85*b*	2.00	2.00*b*	2.00*c*	1.031	.95
Philadelphia	1.825	1.50	1.80	1.65	1.8775	.775	.775
Pittsburgh	1.90	1.50	1.75	1.25	1.75	.80	.70
St. Louis	1.25/1.50	1.50	1.75	1.50/2.00	1.25/1.75	.675/.875	.875
San Francisco	1.75*c*	1.375	1.60	1.50	1.667*c*	.875	.875
Seattle	1.715	1.415	1.615	1.565	1.715	1.015	1.10
Montreal	.92	.81	.87	.76	.90	.53	.46



b 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk.

ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.536
ENR Common Average: $0.780

TIMKEN
TAPERED ROLLER BEARINGS



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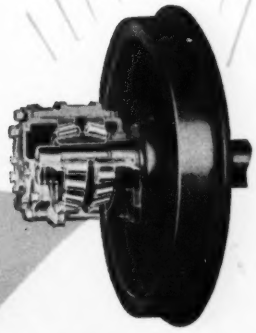
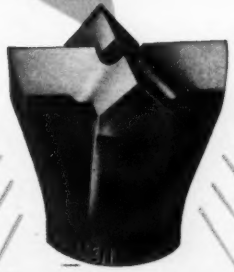


TIMKEN
RAILWAY BEARINGS

TIMKEN
SEAMLESS STEEL TUBING



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—of successful manufacturing companies—whose responsibility it is to buy wisely—usually decide on "Briggs & Stratton" when gasoline motors are needed.
These Machines Are Representative Examples of the Wide Variety of Applications of Briggs & Stratton Motors.
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SICKLE BAR MOWER
Men who make buying their job pay exacting attention to quality, dependability, and value, carefully check the integrity and standing of their suppliers.
And that is why purchasing executives usually prefer to buy 4-cycle, air-cooled gasoline motors for their powered equipment from Briggs & Stratton — the world's largest producers—sizes, 2/3 to 6 HP.
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4 CYCLE
BRIGGS & STRATTON
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MEETINGS

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, 23rd annual convention, Claypool Hotel, Indianapolis, Ind., Feb. 16–18.

AMERICAN TOLL BRIDGE ASSOCIATION, annual meeting, Hotel Peabody, Memphis, Tenn., Feb. 16–18.

AMERICAN CONCRETE INSTITUTE, 38th annual convention, Palmer House, Chicago, Ill., Feb. 17–19.

AMERICAN CONCRETE PIPE ASSOCIATION, New Orleans, La., Feb. 23–24.

AMERICAN ROAD BUILDERS ASSOCIATION, Peabody Hotel, Memphis, Tenn., March 2–6.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Palmer House, Chicago, March 17–19.

REGIONAL AND LOCAL MEETINGS

MINNESOTA FEDERATION OF ARCHITECTURAL AND ENGINEERING SOCIETIES, annual meeting, Nicollet Hotel, Minneapolis, Minn., Feb. 11–14.

OHIO SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, Deshler-Wallick Hotel, Columbus, Ohio, Feb. 12–13.

SOUTHEASTERN STATE HIGHWAY OFFICIALS, first annual meeting, Grove Park Inn Hotel, Asheville, N. C., Feb. 12–13.

MINNESOTA SURVEYORS & ENGINEERS SOCIETY, annual convention, Minneapolis, Feb. 12–14.

MICHIGAN HIGHWAY CONFERENCE, 28th annual meeting, University of Michigan, Ann Arbor, Mich., Feb. 18–20.

HIGHWAY ENGINEERS ASSOCIATION OF MISSOURI, 35th annual convention, Kansas City, Mo., Feb. 18–20.

SOUTHERN SAFETY CONFERENCE, 4th annual meeting, Roosevelt Hotel, New Orleans, La., Feb. 22–24.

The 15th ANNUAL SOUTHWEST ROAD SHOW and SCHOOL, orginally scheduled for Feb. 24–27, has been **postponed indefinitely.**

ASSOCIATION OF HIGHWAY OFFICIALS of the North Atlantic States, Hotel Benjamin Franklin, Philadelphia, Pa., Feb. 25–27.

NEW JERSEY SEWAGE WORKS ASSOCIATION, 27th annual meeting, Stacy-Trent Hotel, Trenton, N. J., Mar. 5–6.

N. J. MOSQUITO EXTERMINATION ASSOCIATION, 29th annual meeting, Atlantic City, N. J., March 11–13.

TEXAS SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, Austin, Tex., March 13–14.

DEFENSE HIGHWAYS

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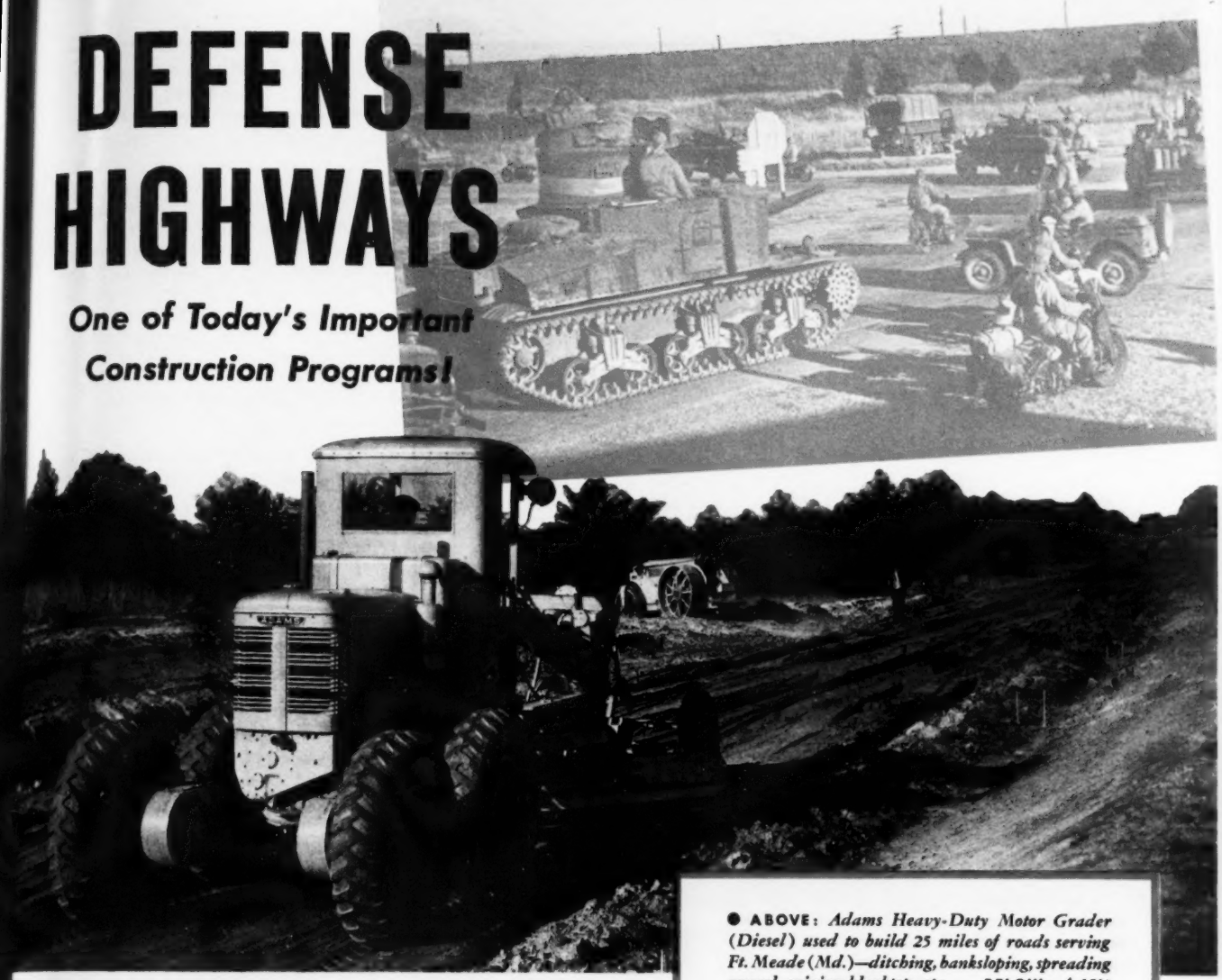

● **ABOVE:** *Adams Heavy-Duty Motor Grader (Diesel) used to build 25 miles of roads serving Ft. Meade (Md.)—ditching, banksloping, spreading gravel, mixing blacktop, etc. . . .* **BELOW:** *A 12½ yd. Adams Hauling Scraper building bridge approach on access road to Ft. Leonard Wood (Mo.).*

HUNDREDS of defense projects have sprung up during the past year which are not yet served by adequate roads. Completion of the government's $150,000,000 access road program is a "high-priority" task in which you may have a part. Adams equipment—with its wide range of application, its ease of operation and dependable performance—is "tailor-made" to handle such jobs with economy and dispatch. Put it on your payroll. ★ ★ ★ For some months much of Adams production has been absorbed in the national defense effort. We regret, sincerely, any delays which may be experienced in delivering "non-defense" orders and beg the indulgence of those affected for the good of the common cause.

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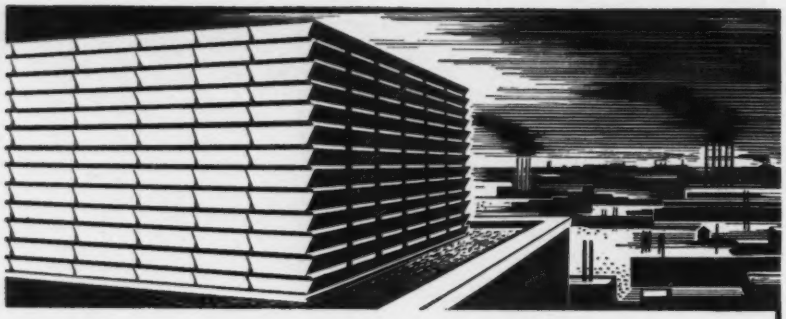

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THIS COOLING TOWER, though exposed for eleven years to a constant rain of spray and the weather, is "as good as new" today. Credit Wolmanized Lumber* with another win over the elements; untreated wood often fails within 3 to 4 years on jobs like this.

CONVINCING EVIDENCE is thus again presented that Wolmanized Lumber adds long life to the other advantages of wood construction: lightness, strength, resilience, and low cost. Vacuum-pressure impregnation with Wolman Salts* preservative, under strict laboratory control, gives it the ability to withstand decay and termite attack.

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WOLMANIZED LUMBER

Elections and Activities

THEODORE BLOECHER of Wheeling, W. Va., is the new president of the West Virginia Society of Professional Engineers. Mr. Bloecher is a division engineer for the Baltimore & Ohio Railroad. Other officers elected are: Owen M. Jones, of Glen Ferris, first vice-president; William S. Downs, of Morgantown, second vice-president; Robert Williamson, Jr., of Charleston, treasurer. George C. Barnes, of Williamson, H. P. Davis, of Morgantown, P. K. Pierpont, of Bluefield, and George W. Zimmer of Wheeling, were elected as directors.

C. J. HANSON, of Worthington, Minn., resident state highway engineer, has been elected president of the seventh district, Minnesota Association of Professional Engineers.

AT THE BIENNIAL MEETING of the Nebraska Section of the American Society of Civil Engineers held recently at Paxton, Neb., Guy P. Dorsey of Omaha was elected president. O. H. Harkness, of Lincoln, was made senior vice-president, and E. W. Woodbridge, of Omaha, was chosen secretary.

THE GEORGIA CHAPTER of the American Society of Civil Engineers, meeting at Atlanta, conferred life membership on three prominent Georgia engineers. They are: C. E. Kauffman, city of Atlanta bridge engineer; James H. Johnston, Georgia Public Service engineer, and vice chairman of the Atlanta Planning Commission; and Col. F. W. Alstaetter, district engineer of the U. S. Engineer Office at Savannah, Ga.

THE WISCONSIN ROAD BUILDERS ASSOCIATION, at its 29th annual meeting held in Milwaukee recently, re-elected Louis G. Arnold, of Eau Claire, Wis. as president. Other officers re-elected were: J. L. Burch, of Madison, vice-president; N. M. Isabella, of Madison, secretary, and A. E. Boundsall, Kenosha, treasurer.

FRANCIS A. HEINF, chief engineer of the Reading, Pa., municipal water bureau, has been elected president of the Reading chapter, Pennsylvania Society of Professional Engineers.

IN RECOGNITION of 30 years of service to the city of Rochester, N. Y., Harry R. Moulthrop, city engineer, was given a citation reward from the American Public Works Association at a recent meeting of the Rochester Chapter of the APWA.

AT THE DECEMBER MEETING of the Engineers Club of North Carolina at Asheville, N. C., Lee G. Warren, project manager, of Cherokee Dam, presented a paper on "Construction of the Cherokee Dam" with motion picture illustrations

(*Continued on page* 150)

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HAYWARD CLAM SHELL BUCKET, TYPE "E"

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Today's most pressing shortage is time. Every day, every hour saved now is just that much more precious time available to help the nation meet the emergency's crucial needs.

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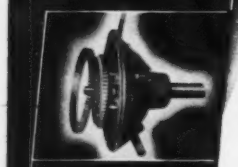

7 factory-controlled branches manned by fully equipped field engineers ready to assist and advise you on any clutch or hydraulic drive problem.

30 parts and service stations, with competent help ready . . . will help you to prevent shut-downs or serious delays due to unforeseen accident or the breakage of any clutch part.

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taken by T. F. Taylor, construction engineer. New officers elected for the year at this meeting are as follows: Fred V. Doutt, of Canton, president; Raymond F. Bennett, of Pisgah Forest, vice-president; John P. Dosier, of Asheville, secretary; R. G. Thyse, of Asheville, treasurer. A. H. Vanderhoof of Asheville, R. B. Fuller of Biltmore, G. R. Hall of Enka, J. Heykoop of Enka, and Walter J. Parks of Camp Davis, were elected directors.

L. M. GAINES has withdrawn from the firm of Ligon & Ligon, contractors of Baltimore, Md., to organize a joint contracting business with T. Gordon Bautz; the firm to be known as Gaines & Bautz, contractors. The firm will specialize in utility construction. Their offices will be located at 212 Washington Ave., Towson, Md.

THE DAYTON SECTION of the American Society of Civil Engineers elected the following officers for 1942: President, M. W. Tatlock, superintendent of sewage treatment, city of Dayton; first vice-president, Charles Beltz, professor of civil engineering, University of Dayton; second vice-president, H. H. Lester, engineer, U. S. Soil Conservation Service; secretary-treasurer, William Kiser, industrial engineer, the Hill-Smith Co.

THE FIRST MEETING of the year of the Northwestern Section of the American Society of Civil Engineers was held at the University of Minnesota, Jan. 5. At this meeting, Mr. Louis Yager, assistant chief engineer of the Northern Pacific Railway, who has just returned from a trip to Japan, discussed "An Engineer's Impression of the Orient as related to the present conflict with Japan." New officers for 1942 are: George J. Schroepfer, chief engineer, Minneapolis-St. Paul Sanitary District, of St. Paul, president; George M. Shepard, chief engineer, city of St. Paul, first vice-president; P. R. Speer, district engineer, U. S. Geological Survey, second vice-president; and Frank S. Altman, district engineer, Portland Cement Association, Minneapolis, secretary-treasurer.

L. O. STEWART, professor at Iowa State College, has been elected chairman of the North-Midwest Section of the Society for the Promotion of Engineering Education.

AT THE 21ST annual joint convention of the North Carolina section of the American Water Works Association and the North Carolina Sewage Works Association, held at High Point recently, D. McG. Williams, superintendent of the Durham, N. C. water department, was made chairman. H. J. Parks, of Camp Davis, N. C., was named vice-chairman, and R. S. Phillips of Durham, N. C., was re-elected secretary-treasurer for the fifth time. The Fuller award for outstanding

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you will reply: "Because it outlines, clearly, concisely, all the responsibilities of a foreman, plus the qualities of mind and character that make for successful foremanship, at a time when good foremen are hard to find."

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you will reply: "Because I can use it as a complete classroom guide, or for group discussions. It is based on such a thorough knowledge of construction problems that even my most experienced men will profit from it."

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you will reply: "Because it is written by men who know foremanship in the construction industry from the ground up. Every page is jam-packed with suggestions that simplify and improve my work."

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Foremanship — the foreman's responsibility to his job, to the superintendent, to his men, to his fellow foremen, to subcontractors and the general public; qualities which make for successful foremen . . 7

Chapter II

The Foreman's Place in Accident Prevention — planning for accident prevention; accident investigation; developing the accident prevention program 15

Chapter III

The Foreman and His Men — selection and hiring, placing and training, supervisory methods 23

Chapter IV

Job Planning — in relation to long range planning, layout of the job, receipt of materials, day-to-day plan 33

Chapter V

Physical Protection — excavation, staging and scaffolding, runways and platforms, barricades, overhead protection, clothing 41

Chapter VI

Care, Use and Storage of Equipment — principles of selection, testing and inspection; rigging, hand tools, supports, derricks, scaffolds, safe practice rules, machine operators, trucks, cranes, moving equipment, moving material, air equipment, machine guards, yard storage, tool storage 51

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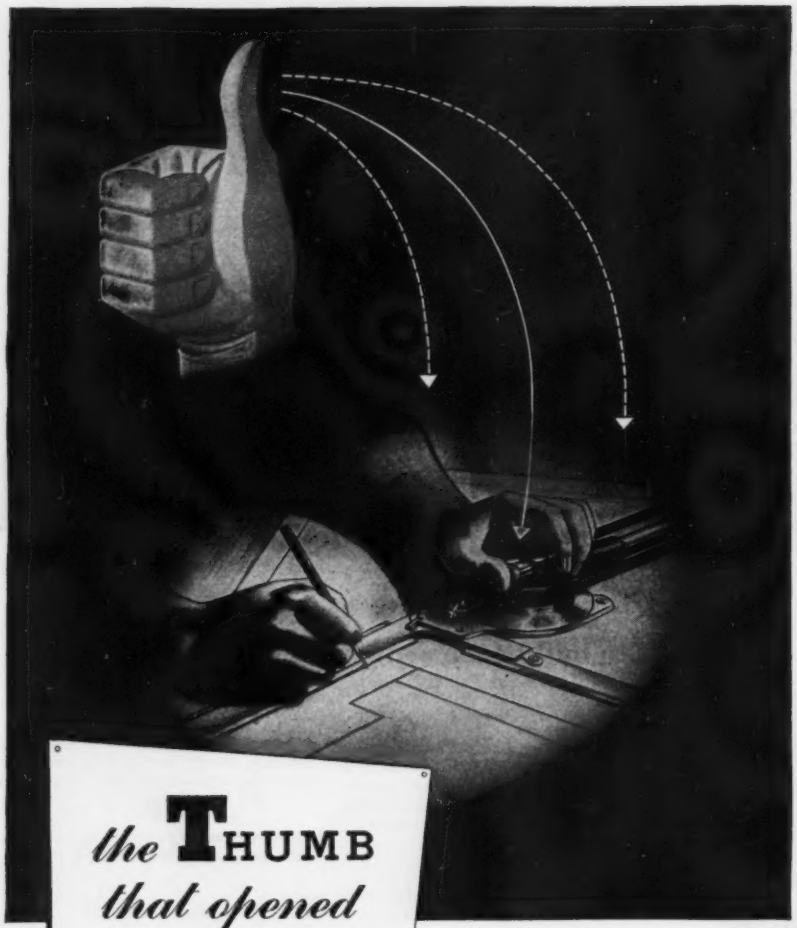

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work done during the past year was awarded to W. C. Olsen, consulting engineer, Raleigh, N. C., and W. M. Franklin, of Charlotte, was awarded the Maffitt membership cup for having obtained the most members during the year. Among the speakers at the convention were: Louis R. Howson, president of the American Water Works Association; Harry E. Jordan, secretary of the American Water Works Association; A. S. Bedell, president of the Federation of Sewage Works Associations; J. R. Malone, chemist with the Durham, N. C. water department. A two-reel color sound moving picture, "The Stone Canyon," Inlet-Outlet Line of Bureau of Water Works and Supply, Los Angeles, Cal. was shown.

W. B. GIBSON, of Fort Myers, Fla., was named chairman of the board of the Florida section of the American Water Works Association at the 15th annual convention held recently at Daytona Beach, Fla. Other officers chosen were: J. R. Hoy, Jacksonville, vice chairman; A. P. Black, Gainesville, secretary-treasurer. The Fuller award for outstanding work in the waterworks field was presented to Mr. W. B. Gibson.

THE MISSISSIPPI State School of Engineering at State College, Miss., has been accredited by the Engineering Council for Professional Development. Dr. D. G. Humphrey is president of the college.

THE CHARLESTON CHAPTER of the West Virginia Society of Professional Engineers at the recent annual meeting re-elected George H. Hill, Jr. as president. J. B. Latterner was named vice-president; Homer D. Willman, secretary-treasurer, and J. M. Clark, Sr. and H. B. Hickman, directors. The main speaker before the meeting was E. L. Worthington, maintenance engineer of the West Virginia State Road Commission.

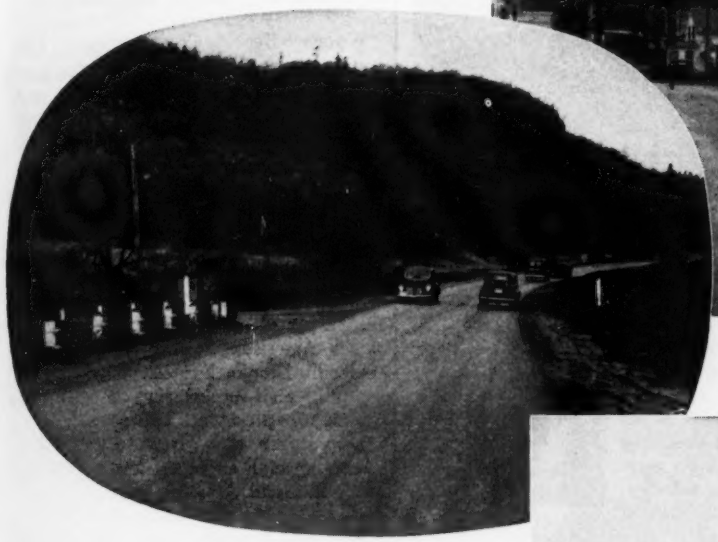
GOVERNOR J. M. BROUGHTON of North Carolina has reappointed the following to the North Carolina State Board of Registration for Engineers and Land Surveyors: J. E. Lear of Raleigh, N. C.; A. C. Lee of Charlotte; J. E. S. Thorpe of Franklin, and Grady S. Harrell of Shannon, N. C.

THE PHILADELPHIA CHAPTER of the Pennsylvania Society of Professional Engineers at a recent meeting elected Robert V. Hudson president for 1942. Other officers chosen were: C. Paul Schantz, vice-president; Henry F. Bamberger, secretary; Wilbert C. Cornell, treasurer, and Milton Blez, state director.

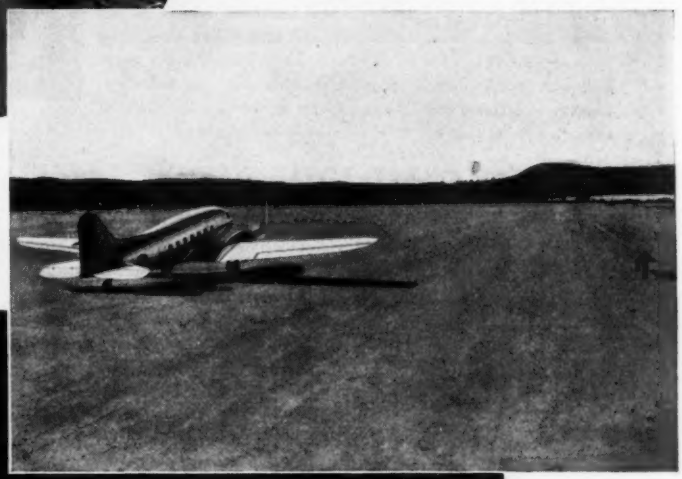
MORE THAN a thousand members of the Associated Pennsylvania Constructors attended the recent annual convention at Philadelphia.

F. B. FREELAND, chief engineer of the British Columbia provincial department

Lowell, Massachusetts, built over 13 miles of soil-cement streets like this in 1938-39-40. All in excellent condition. →



← This soil-cement road in Adams County, Wisconsin, is in excellent condition after five years of service.



An eastern U. S. Army air-base, where a large volume of materials was easily handled by mixed-in-place procedure. 39,000 sq. yds. of soil-cement in a runway 150 ft. wide by 2,460 ft. long were placed in 14 working days. →

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The ideal material for light traffic roads, streets, parking areas and airport surfaces

There is no priority on soil, which is 90% of soil-cement. Cement itself is readily available. And no other type of pavement construction requires so little transportation of materials—a fact of importance when shipping facilities are taxed to the limit by defense haulage.

These are just extra reasons why you should use soil-cement this year. Of even greater importance is the fact that this type of construction is:

SERVICE-PROVED. Hundreds of miles of roads and millions of square yards of secondary airport runways now in use prove the durability of soil-cement under all weather conditions.

MONEY SAVING. Soil-cement does for light traffic uses what portland cement concrete does for heavier duty pavements—provides continuous serviceability at low annual cost.

RELIABLE. Tested control technic assures a good job. While certain laboratory tests must be made and the findings applied in the field, the methods are simple to a qualified engineer.

Construction is very rapid and only simple equipment is required. Write for handbook, *"Soil-Cement Roads"* (sent free in the U. S. and Canada), giving methods applicable to light traffic roads, streets and airport runways.

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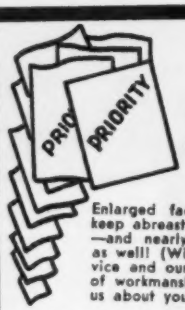

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CELOTEX Absorptive Form Liner removes excess water and trapped air from concrete, producing a smooth, dense, hard outer layer. Better appearance, greater durability, greater abrasion resistance are some of the results! Successfully used on dams, aqueducts, bridge piers, docks, stadia, etc.

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The word Celotex is a brand name identifying a group of products marketed by The Celotex Corporation.

THE CELOTEX CORPORATION
CHICAGO

of mines, has been elected president of the Association of Professional Engineers of British Columbia. W. M. Hill was made vice-president and A. C. Creer, secretary-manager. The chief guest of the meeting was D. A. R. McCannell, city engineer of Regina, and president of the Dominion Council of Professional Engineers.

WOODS BROS. CONSTRUCTION CO., Omaha, Neb., has merged with the Lancaster Corp., general contractors, with offices at 504 South 18th St., Omaha, Neb.

THE EASTERN OHIO Professional Engineers Society has re-elected John Davis as 1942 president.

GEORGE E. BARNES, head of the civil engineering department of the Case School of Applied Science, has been elected president of the Cleveland section of the American Society of Civil Engineers. G. Brooks Earnest, assistant professor of civil engineering at Case, was chosen vice-president. The post of secretary-treasurer was given to Leland L. Olson, special engineer for the Nickel Plate Railroad.

STANLEY LEARNED, assistant manager of the gasoline pipeline department of the Phillips Petroleum Co. at Bartlesville, Okla., was elected president of the Oklahoma Society of Professional Engineers, at an annual meeting held at the Mayo Hotel, Tulsa, Okla. Other officers elected included: W. R. Wooten, Tulsa city engineer, vice president; John Stobaugh, Jr., of Oklahoma City, secretary; M. G. Fuller, of the U. S. Engineers district office at Tulsa, treasurer.

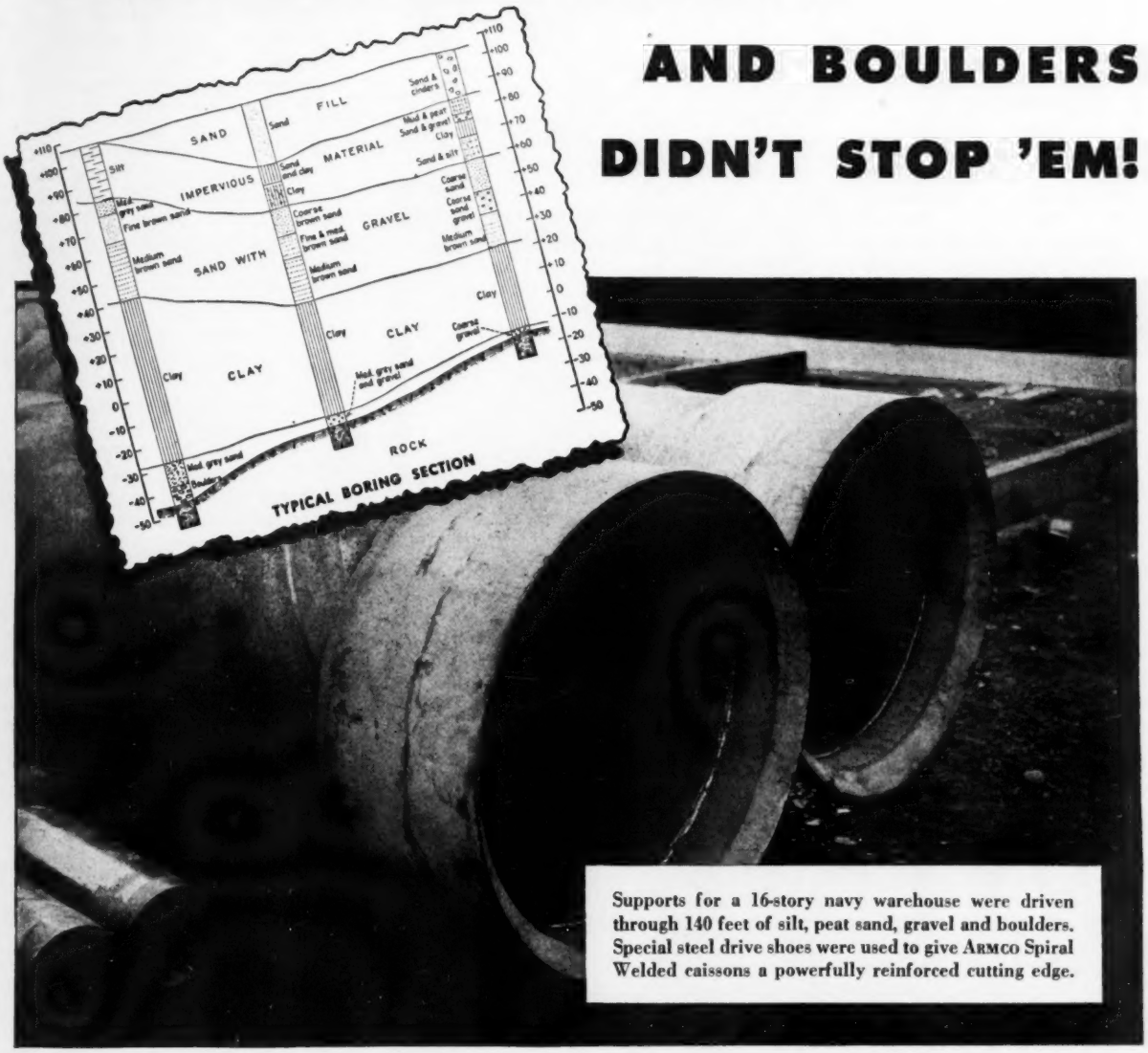
WILLIAM H. WISELY, engineer-manager of the Urbana-Champaign Sanitary District, was elected president of the Central Illinois section of the American Society of Civil Engineers at the section's annual meeting. Other new officers are: Walter B. Worsham, materials engineer of the Illinois Department of Public Works and Buildings, first vice-president; Harold E. Babbitt, professor of sanitary engineering at the University of Illinois, second vice-president; Henry P. Evans, associate in civil engineering at the University of Illinois, reelected secretary-treasurer. T. C. Shedd, professor of structural engineering at the University of Illinois, was appointed director to the Illinois Engineering Council for a three-year term.

THE METROPOLITAN BUILDERS ASSOCIATION, New York City chapter of the Associated General Contractors, reelected William Joshua Barney, of New York, as president of their group for his third consecutive term at a meeting held in New York last month.

ROBERT B. RICE, head of the department of experimental engineering at

140 Feet to Bedrock...

AND BOULDERS DIDN'T STOP 'EM!



Supports for a 16-story navy warehouse were driven through 140 feet of silt, peat sand, gravel and boulders. Special steel drive shoes were used to give ARMCO Spiral Welded caissons a powerfully reinforced cutting edge.

The contractor called it "the most difficult foundation in almost 30 years' experience." Bedrock was 140 feet down with large boulders above it. Yet "Spiral Welded" pipe caissons were "drilled-in" successfully — thanks to the contractor's ingenuity and the cooperation of ARMCO metallurgical engineers.

You can confidently use ARMCO Spiral Welded drive shells, pipe piling and caissons on your toughest foundation jobs. "Spiral Welded" is known for its strength, straight driving, water-tightness and a uniformity of diameter that permits full salvage of cut-off pieces. These advantages save time and money.

By using "Spiral Welded" you can order any specified length (not random) that can be handled and shipped. Diameters range to 36 inches and wall thicknesses from 3/16 to 1/2-inch. When required, end plates, cone points or cutting shoes can be mill attached. Quotations and shipping promises on request. The American Rolling Mill Company, Pipe Sales Division, 601 Curtis St., Middletown, Ohio.

ARMCO ARMCO **Spiral Welded Pipe For Piles**

"WE HAVE USED THIS BUCKET FOR 2½ YEARS AND RECOMMEND IT TO ANYONE WHO DEMANDS STEADY AND MAXIMUM PRODUCTION"
THE CITY EXCAVATING CO.

"We have long since realized," writes A. J. Carlozzi, president of The City Excavating Co., Cleveland, Ohio, "that your ½ yard Multiple Rope Bucket gives us far better service than any other make previously used, and we have used several other makes of buckets."

Williams Buckets are truly "built to last and move dirt fast." Each type we build has numerous features which have been developed by over 35 years of bucket engineering for contractors, dredging companies and steel mills. Always a leader in welded design, Williams Buckets now feature welded construction at vital points, using rivets only at certain sections where ultimate replacement may be required. Make your next bucket a Williams!

Send for individual bulletins giving full information on each type of Williams Bucket.

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ROLLED STEEL CONSTRUCTION
for GREATER STRENGTH *and* SPEED

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***built by* WELLMAN**

OHIO
LOCOMOTIVE CRANES
15 to 50 TONS CAPACITY
DIESEL-ELECTRIC-GASOLINE-STEAM
The OHIO LOCOMOTIVE CRANE CO.
BUCYRUS OHIO

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Wood Preservers Since 1878
Treatment with
CREOSOTE • C.Z.C.
Pressure Process
80 EIGHTH AVE., NEW YORK, N. Y.
POLES, CROSS ARMS, PILING, TIES
POSTS, BRIDGE AND DOCK TIMBERS
TREATING PLANTS
Jacksonville, Fla. Long Island City, N. Y.

North Carolina State College, Raleigh, N. C., has been appointed secretary of the North Carolina Society of Engineers. The post of secretary had been left vacant at the society's annual meeting Jan. 16, the appointment being left in the hands of the newly elected president, Channing B. Brown, of Charlotte.

THE NORTH DAKOTA HIGHWAY CONTRACTORS' Association elected George Haggart, of Fargo, N. D. as president for the coming year. Other officers elected include: J. A. Jardine, of Fargo, vice president; Jessie Blewett, Jamestown, secretary.

THE KENTUCKY SOCIETY OF PROFESSIONAL ENGINEERS has elected James B. Wilson, of Louisville, to the presidency of the group. At a meeting held last month in Lexington, M. J. McGruder, of Lexington, was elected first vice president; E. A. Marye, of Louisville, second vice president, and Prof. C. S. Crouse, of Lexington, was reelected secretary-treasurer.

A. M. BRENNEKE, member of the defense division staff of the Denison District, U. S. Engineers, is the new head of the Denison Post, American Society of Military Engineers. Other officers elected at a recent meeting are Darwin Harbin and Lieut. George Burch, vice president; Aymar Cater, secretary; H. F. Michael, treasurer.

MORE THAN 300 members of the Canadian Construction Association attended the group's annual meeting at the Seigneury Club, Montebello, Que. last month, to elect John B. Sirling, of E. G. M. Cape & Co., Ltd., general contractors of Montreal, as president.

JOHN J. LUCAS, civil engineer in the city utilities department, has been elected president of the Cleveland Society of Professional Engineers at a recent meeting. Clayton T. Elder, of the Cleveland Electric Illuminating Co., was elected vice-president; Frank J. Schwemler of the county engineers' office, elected secretary, and Fred Gaub, also of the county engineers' office, elected treasurer.

NEW OFFICERS of the Idaho Society of Engineers, elected at a convention at Boise, Idaho last month, include Raymond J. Briggs, of Boise, president; L. E. Stalker, of Idaho Falls, vice-president; W. P. Eaton and Sidney Harris, both of Boise, secretary and treasurer, respectively.

CARL ERICKSON, Erickson Paving Co., Seattle, Wash., will head the Mountain-Pacific Chapter of the Associated General Contractors for the coming year. Other officers elected at an annual meeting at

EASY BUCKET SPOTTING WITH KOEHRING *Boom Control*

KOEHRING Boom Control is Accurate

Quick and easy clamshell or dragline bucket spotting saves seconds with every load. Accurate boom control . . . Koehring control . . . is reason why Koehring cranes have advantage of high speed loading or unloading . . . in batching plants . . . car unloading . . . handling concrete buckets . . . in industrial plants. Easy steering permits quick travel direct to operating location. No time lost "jockeying" for position. Boom operation and hoisting while swinging or traveling is another important second-saver. The many time-saving advantages of Koehring means speed on the job . . . more production per hour.

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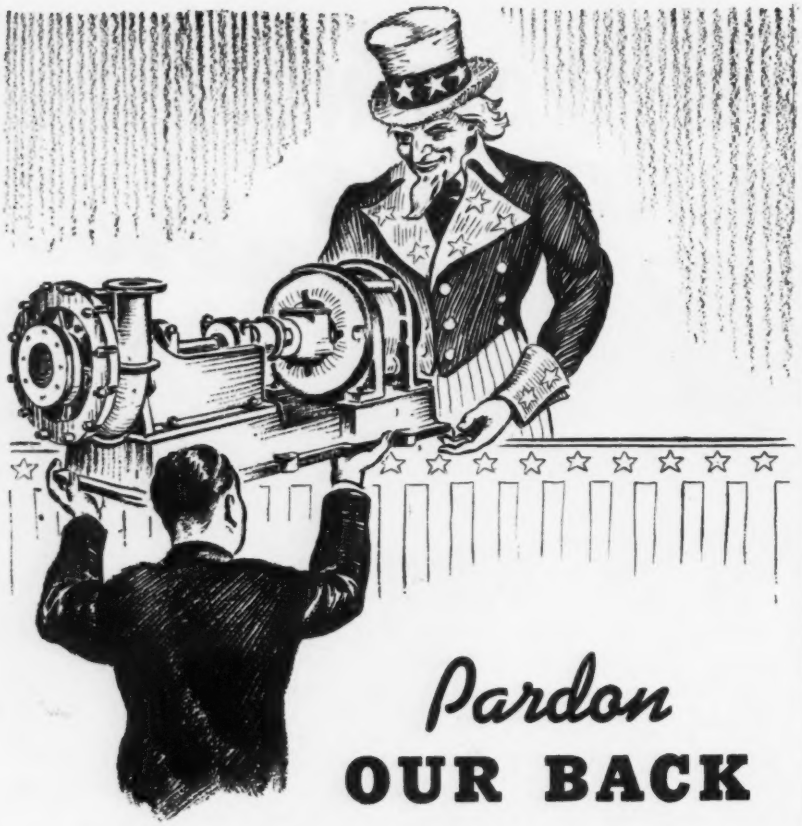

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It's all because our centrifugal pumps are mighty good. Uncle Sam heard about it . . . you know how those things get around . . . and said to us, "Boys, I need you for the duration." So here we are . . . most of the time facing Uncle Sam . . . our back to you temporarily.

But if our pumps weren't good, Uncle Sam wouldn't use them, and you wouldn't want them, either. So in asking your indulgence for being unable to serve you as fully and as promptly as we would like, we also ask you to remember that when the war is over, we'll be all the better prepared to build pumps for you of the same excellence that made Uncle Sam call on us.

Meanwhile, our engineering department is at your service for advice on making your present pumps give better service, and for recommendations on future centrifugal pump requirements.

MORRIS MACHINE WORKS — MORRIS ESTABLISHED 1864 — BALDWINSVILLE NEW YORK

CENTRIFUGAL PUMPS

Seattle include: Elmer While, McRae Bros., Seattle, vice-president; L. Paul Fiorito, of the Northwest Construction Co., Seattle, treasurer; W. D. Show, secretary-treasurer.

C. DANA WARD, Indianapolis, has been elected president of the Indiana Highway Materials and Equipment Association, at an annual meeting at Lafayette. Other officers included Fred G. Johnson, vice-president; Arthur G. Wilson, treasurer; both of Indianapolis, and Walter H. O'Neill, Crawfordsville, secretary.

FIVE PITTSBURGH ENGINEERS recently were awarded life memberships in the American Society of Civil Engineers. The recipients were Clifford George Dunnells, Edward Godfrey, Elmer Kirkpatrick Hiles and Newton Fisher Hopkins, all of Pittsburgh, and Shirley Clark Hulse, of Bedford, Pa.

COL. STANLEY L. SCOTT, chief of the Southwest division of U. S. Engineers, will head the Dallas post of the American Military Engineers Society, following his election to the presidency at a meeting in Dallas last month.

W. G. MILLER, city engineer of St. Thomas, Ont., has been installed as president of the Association of Professional Engineers of Ontario, after his election at an annual business and general meeting held in Toronto last month.

THE LOUISVILLE ENGINEERS AND ARCHITECTS CLUB, at its annual meeting Jan. 21, named P. E. Payne, chief engineer of the Louisville Water Co., as president; J. L. Thompson, engineer for the Kentucky Actuarial Bureau, as vice-president; and George W. Hubley, consulting engineer, as secretary.

MORE than 950 county, state and city road engineers and supervisors, attended the annual Indiana County Road Supervisors' Association meeting held at Lafayette last month. Officers elected for the coming year included Vaughn Crowe, of Bedford, president; Lemuel Carey, of Noblesville, first vice-president; Ronald Wirt, of Madison, second vice-president; and Ernest H. Coffin, of Richmond, secretary-treasurer.

AT THE ANNUAL MEETING of the Province of Ontario Association of Professional Engineers, held last month at Toronto, W. C. Miller, of St. Thomas, Ont., was named president, and Lt. Comdr. C. P. Edwards, of Ottawa, was named a member of the Council.

MEXICAN GEOLOGICAL SOCIETY officers who were elected at a recent meeting in Mexico City include: Permanent honorary president Ezequiel Ordonez; execu-

Photo by U. S. Army Signal Corps

GUARDIANS OF A VICTORIOUS AMERICAN INDUSTRY

. . each a triumph of exact specifications

America's Victory will be won in her industrial plants — great and small — as well as in battle. Every plant, every worker must render maximum service. This requires the best in equipment and facilities, not only the tools men use but the floors they work on.

Hastings Asphalt Block Floors, *made to exact specifications,* fit right into today's picture of all-out high speed production. They are tough; they have "built-in" foot-comfort; their prefabricated block units are quick to install and easy to maintain without slowing up operations . . . they are ready for the job to be done.

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For better building
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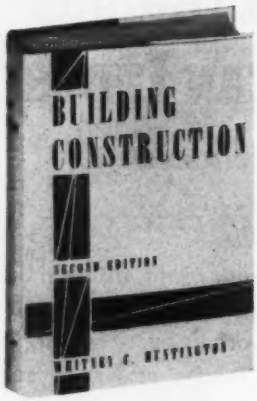
BUILDING CONSTRUCTION

Second Edition

By **WHITNEY C. HUNTINGTON**
Professor of Civil Engineering and Head of the Department, University of Illinois



A complete modern treatment of types of construction used for the various parts of buildings, and the materials used in building construction. Terms employed in building construction are defined, and full explanations are given.

Note the up-to-date information on:

The effect of soil mechanics on foundations; new types of foundations; the use of welding and flame cutting, especially in connection with steel rigid frames; modern connectors for timber trusses and rigid frames; the construction of long-span rigid frames of reinforced concrete; **the newer materials,** such as glass blocks, asphalt flooring tile, plywood and fiber boards, structural clay facing tile, structural steel piles, termite shields, etc.; also introductory material on the insulation of buildings to reduce heat losses, and on acoustics.

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tive president, Manuel Santillan; vice president, Luis Blasquez; Jose Rodriquez Cabo, secretary; assistant secretary Manuel Alvarez, Jr., and Francisco Contreras, treasurer.

WELDON WILLIS, of Marion, N. C., was elected president of the North Carolina Society of Surveyors at the organization's annual meeting held at Raleigh, N. C. last month. J. W. Blanchard, of Rose Hill, was elected vice-president, and C. L. Mann, of Raleigh, was renamed secretary-treasurer.

OFFICERS inducted at the annual meeting of the Louisiana Engineering Society, held at New Orleans, La. last month, included C. Glenn Cappel, of New Orleans, president; Karl P. Kammer, of New Orleans, first vice-president; Frederick F. Pillet, of Baton Rouge, second vice-president, and John K. Mayer, secretary-treasurer.

NAMED as new officers for the Associated Contractors of North Dakota are J. H. Mackley, of Minot, president; William Gillanders, of Grand Forks, first vice-president; Arthur Johnson, of Fargo, second vice-president; A. J. Weinberger, of Bismarck, reelected treasurer, and H. M. Montgomery, of Minot, reelected secretary.

L. D. HOWARD, of Pierre, safety engineer of the South Dakota State Highway Commission, has been elected president of the South Dakota Society of Engineers and Architects. He succeeds Ralph Reed, of Watertown, who was named vice-president for the current year. J. C. Robinson, of Pierre, was renamed secretary-treasurer.

AT A MEETING of the Wisconsin County Highway Commissioners' Association held at Milwaukee, George Batty, of Portage, was elected president. Other officers elected included R. B. Bierl, of Sturgeon Bay, vice-president, and Ray Jensen, of Chilton, secretary-treasurer.

PROF. GEORGE E. BARNS, head of the civil engineering department of the Case School of Applied Science, was elected president of the Cleveland Section of the American Society of Civil Engineers at a recent meeting.

J. F. HOLLEY, of Birmingham, was elected president of the Alabama branch, Associated General Contractors of America, at an annual meeting held last month in Birmingham, Ala.

THE ASSOCIATED GENERAL CONTRACTORS OF MINNESOTA held their annual convention at Minneapolis, Minn. last month, electing O. M. Swanson, of St. Paul, as president; W. M. Cederstrand,

***Sure,* WE STERLINGS CAN "TAKE IT" *because* WE ARE BUILT THAT WAY!**

Whether they are called to work normal hours on routine construction jobs or 24-hour days, 7 days a week on mammoth miracle projects for the war emergency, STERLING WHEELBARROWS are engineered and built to "take it" . . . they are the dependable, service-proven "veterans" of material-transport, assuring STERLING performance always, economically . . . the SIMPLEST, RELIABLE, LOW-COST METHOD OF MATERIAL TRANSPORT.

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Look for this Mark of STERLING Quality
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"Hypochlorites Soon to Disappear from Market"
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but don't let them fool you,

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but also (3) Hypochlorite liquids (Sodium or Calcium)

All three are covered by Preference Rating Order M-19, and *all* carry a priority of A-2 when used for public health protection. There are no more stringent restrictions on hypochlorite liquid than there are on gas.

Ask Mathieson Alkali Co. for up-to-date information on HTH. Ask Pennsylvania Salt Co. for information on Perchloron. Ask any of the hundreds of manufacturers of Sodium Hypochlorite in the form of soda bleach or bleach water such as Klenzade, Chlorox, Wilchlor, Merchlor, etc., all over the country, for information on their product. . . . There's a hypo producer within shipping distance of every state in the U.S.A. Then if you *still* worry about shortage, ask the Priorities Chemicals Division

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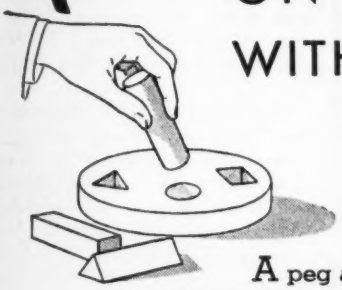
Replace WORN CABLE ON YOUR SCRAPER EQUIPMENT WITH "FLEX-SET" PREFORMED YELLOW STRAND



A peg and its hole, a scraper and its cable . . . for each there is *one best fit.* And because pay loads move faster, more smoothly and at lower cost with "Flex-Set" Preformed Yellow Strand on the job, it's the "must have" choice of contractors and operators in ever-growing numbers.

When you replace worn wire rope with a new reel of free-running Yellow Strand, you get the specific size, length and construction engineered for your machines. You get the correct field-tested safety factor: proper balance between line pull and rope strength, to forestall costly shut-downs for machine repairs. Preforming supplies the limberness that makes handling easy . . . curtails kinking . . . prolongs rope life mightily by resisting metal fatigue.

On cable controlled equipment the *cable* itself is no place to experiment. Protect your investment by making sure that the rope you install has a yellow strand. Broderick & Bascom build it for you, combining the quality of finest drawn-to-order steel wire with the performance that comes from 65 years of concentration on wire rope applications. Our distributor in your locality stocks and gives quick service on your special scraper cable. Start with Yellow Strand . . . *stay* with Yellow Strand . . . for savings you can see and measure.

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Yellow Strand helps keep pay yards and profits rolling: by requiring fewer cable changes . . . by taking the shocks that would otherwise damage vital parts and cause expensive delay. Accept no substitute for time-tried Yellow Strand "Flex-Set" Preformed Wire Rope on

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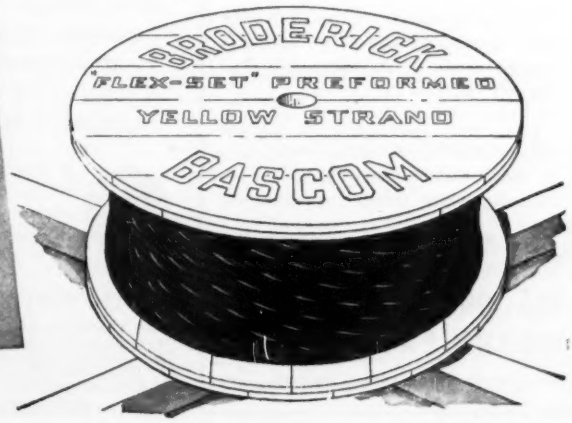

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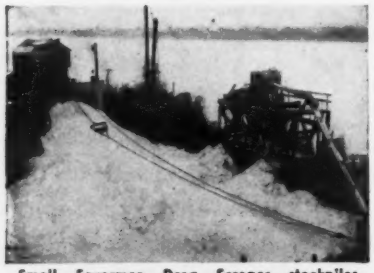
This 2 cu. yd. Sauerman Slackline Cableway digs down to the bottom of a deep gravel deposit and hauls the material to the top of screening plant at rate of 90 cu. yd. per hour.



Small Sauerman Drag Scraper stockpiles crushed silica rock on ground alongside washery and reclaims this stored material when and as required to drying plant.

For over 30 years SAUERMAN Cableway Excavators, Power Drag Scrapers and Tower Machines have dug, moved, and placed earth, gravel, clay, blasted ore, sand, rock and coal on thousands of different jobs all over the world.

Increase your profits by taking advantage of the many economies available with SAUERMAN Machines such as: wide versatility and speed, one-man operation, extremely low power and maintenance costs, and reliable, steady service.

These machines are built in a wide range of sizes with capacities up to 1,000 tons per hour and operating spans up to 1500 ft.

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HI-WAY SURFACERS

MODEL H-8
Without Clutch
MODEL H-10
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The above models are one-man, gasoline driven machines, for surfacing concrete roads, streets, floors, and other concrete paving.

The Power Take-Off is an EXCLUSIVE FEATURE, permitting attachment of "Berg" Flexible Shaft Equipment, for surfacing walls, bridges, culverts, etc.

Pioneers in Concrete Surfacing Machinery.

The CONCRETE SURFACING MACHINERY COMPANY

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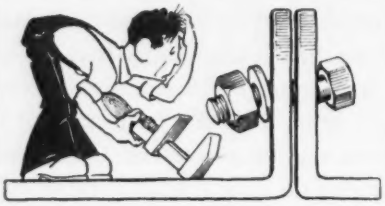

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Elastic Stop SELF-LOCKING NUTS

of Minneapolis, vice-president; Frank B. Winston, of Minneapolis, secretary-treasurer. Robert J. Hendershott was made managing director of the association.

L. A. ELSENER, district manager of the Chicago Bridge & Iron Co., was elected president of the Engineers' Club of San Francisco at the annual club meeting last month. Other new officers are J. Marshall Evans, of the Standard Oil Co. of California, vice-president; Russell P. Hastings, retired civil engineer of San Francisco, as secretary; and J. W. Mahoney, of the General Electric Co., as treasurer.

OLE SINGSTAD, chief engineer for the New York City Tunnel Authority, has been elected president of the Engineers' Club of New York at the organization's 64th annual meeting last month. Other officers elected were Guy W. Vaughan, president of the Curtiss-Wright Airplane Co., vice-president; T. F. Barton, New York district manager for the General Electric Co., vice-president; H. H. Sheldon, of New York, secretary; E. B. Stockmann, of the Consolidated Edison Co. of New York, treasurer.

T. F. HICKERSON, of Chapel Hill, N. C., was elected president of the North Carolina section of the American Society of Civil Engineers, at an annual meeting at Durham, N. C. last month. J. N. Stribling, of Charlotte, was elected vice-president, and George H. Maurice of Eagle Springs, was renamed secretary and treasurer.

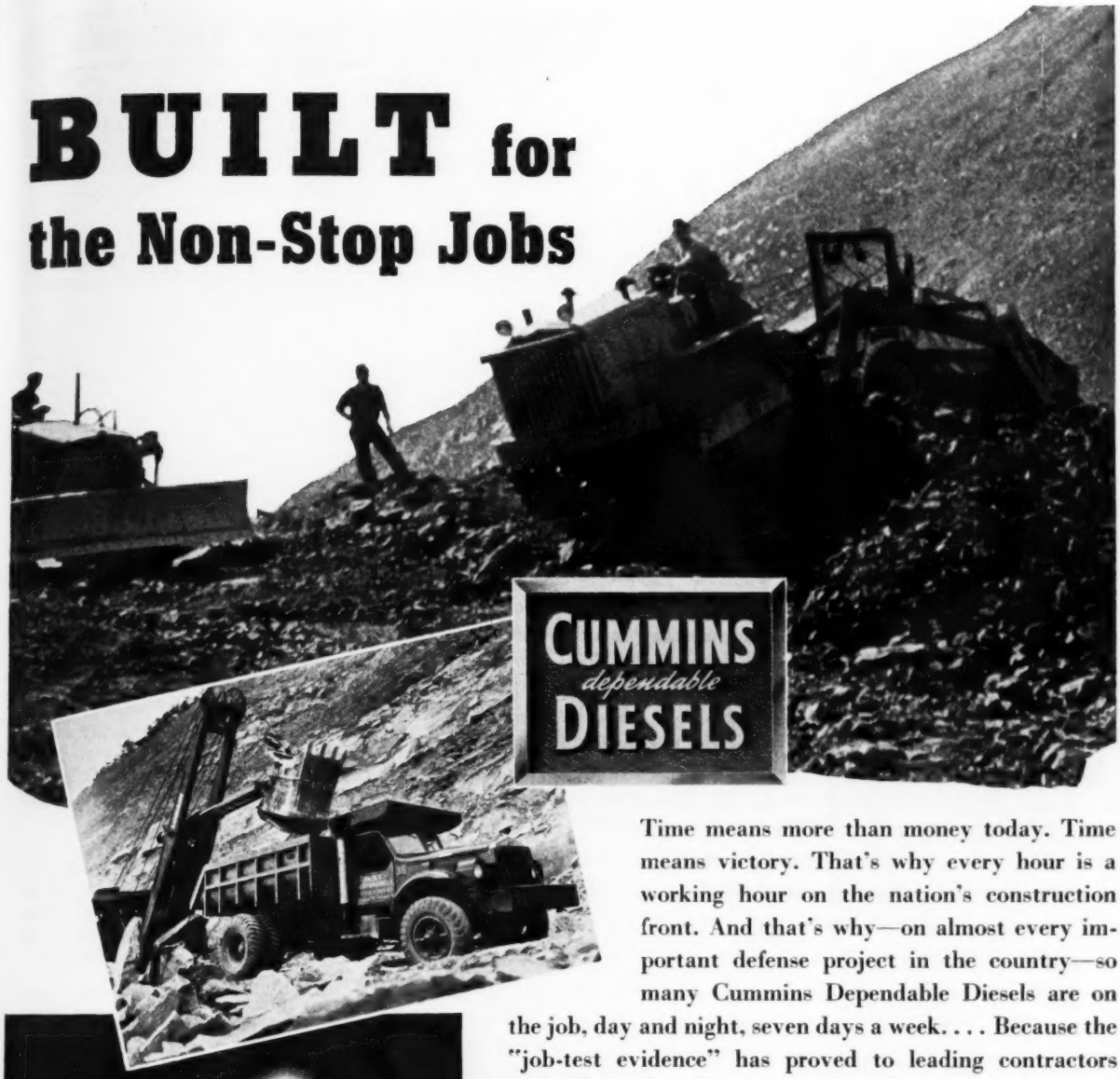
ELECTED at the 57th annual meeting of the Illinois Society of Engineers, held at East St. Louis, Ill. last month were Alex Van Praag, of Decatur, Ill., president; W. W. Wallace, of the Portland Cement Association, Chicago, vice-president, and Prof. H. E. Babbitt of the University of Illinois, secretary-treasurer.

NEW OFFICERS of the Memphis Engineers Club, elected at a recent meeting at Memphis, Tenn., are Garner W. Miller, of the U. S. Engineer office, West Memphis Depot, president; L. D. Lanahan, vice-president, and John J. Ryan secretary-treasurer.

H. R. F. HELLAND, of San Antonio, Tex., was elected president of the Texas Society of Professional Engineers at the organization's sixth annual convention held at Beaumont, Tex. last month.

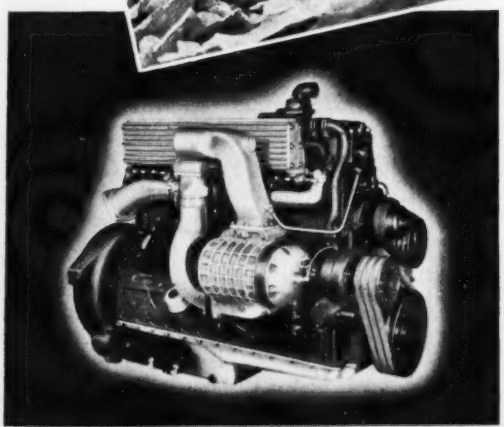
AN experimental course of lectures inaugurated as an educational experiment during the fall on "Humanizing Engineering" by the New York School for Social Research, at 66 W. 12th St., New York, N. Y., is being continued with a second series of 15 lectures, which began Feb. 4 and will run through to May 13.

BUILT for the Non-Stop Jobs



Time means more than money today. Time means victory. That's why every hour is a working hour on the nation's construction front. And that's why—on almost every important defense project in the country—so many Cummins Dependable Diesels are on the job, day and night, seven days a week. . . . Because the "job-test evidence" has proved to leading contractors everywhere that there's no end to the Cummins Diesel's endurance . . . no limit to its ability to deliver full-rated power on a round-the-clock schedule in every heavy-duty service.

Assure uninterrupted operation on your job during the emergency by providing adequate maintenance and service for your Cummins Diesels. Take advantage of the complete parts and service facilities offered by authorized Cummins Dealers in all parts of the country. Cummins Engine Company, Columbus, Indiana.



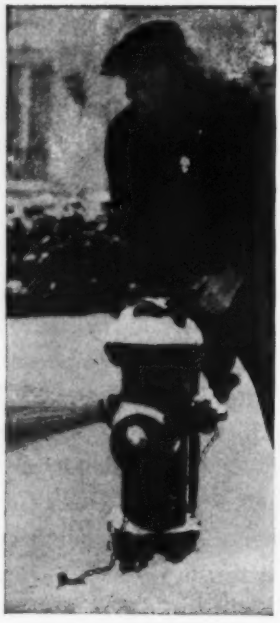
Above: Model HBIS-600 (supercharged) Cummins Dependable Diesel. 200 hp. at 1800 rpm. There's no need to sacrifice more weight and space for extra power . . . supercharging gives you the additional horsepower needed in the same dimensions and with very few changes in your service parts requirements.

ILLUSTRATED AT TOP: *A supercharged Cummins Dependable Diesel powers this Cletrac FDLC tractor with 23-yard Wooldridge Scraper working on a new road cut-off from Portland to Tillimook, Oregon.*

LEFT, ABOVE: *The S. T. Brotemarkle Construction Co., is working five Cummins Diesel-powered trucks on a 2.4 mile highway construction job near Johnstown, Pa. Two of the trucks are 13-yard Sterlings (illustrated) and the others are 9-yard Macks.*

Winter

doesn't interfere with SAFETOP service . . . . . .



FIRE Departments have found that Kennedy SAFETOP Fire Hydrants are as easy to operate, as quickly responsive, and as dependable in Winter as in Summer. The SAFETOP operating mechanism is simple, positive in action, and frostproof; the double automatic drain valves quickly empty the standpipe after service, and the nozzles and chains are arranged to drop immediately out of the way of the hose.

Water Departments, too, find that Winter maintenance of Kennedy SAFETOPS is easy and economical. If broken by a colliding vehicle, the Safety Breakable Section permits speedy repair, without excavation or shutting off the water supply and at a cost of only $6.00 for replacement parts. There are no bulky flanges on the ground line which might be broken by frost upheaval, and there will be no cause for complaint about congealed operating mechanisms, leaky valves, or other difficulties.

These are some of the reasons for the increasingly rapid adoption of Kennedy SAFETOPS for replacements and extensions all over the country. Write for bulletins which fully describe the special advantages of this unique design.

THE KENNEDY VALVE MFG. CO.
Elmira, N. Y.

KENNEDY
SAFETOP FIRE HYDRANT
REG. U.S. PAT. OFF.

MEN AND JOBS

H. M. Cresap, a project engineer for the Wyoming State Highway Department since 1936, resigned recently to take a post as plant foreman with the Remington Arms Co., Inc., at Salt Lake City, Utah.

Julian Kheel, formerly a designer for the Bureau of Ships, Navy Department, Washington, D. C., has been commissioned an ensign in the Civil Engineer Corps, U. S. Navy, and is now stationed at the supply depot, at Mechanicsburg, Pa.

Carl C. Lanford, city superintendent of public works at Newton, N. C., has resigned to accept a similar post at Greer, S. C.

Peter C. Killeen has been appointed general manager of a defense project at the U. S. Marine Corps Base at Jacksonville, N. C., by the Federal Works Agency. Mr. Killeen recently completed supervising construction of a housing project at Indian Head, Md.

G. H. Ehringer, resident engineer for the North Carolina State Highway and Public Works Commission, at Salisbury, N. C., resigned recently to accept a post with the U. S. Engineer Corps.

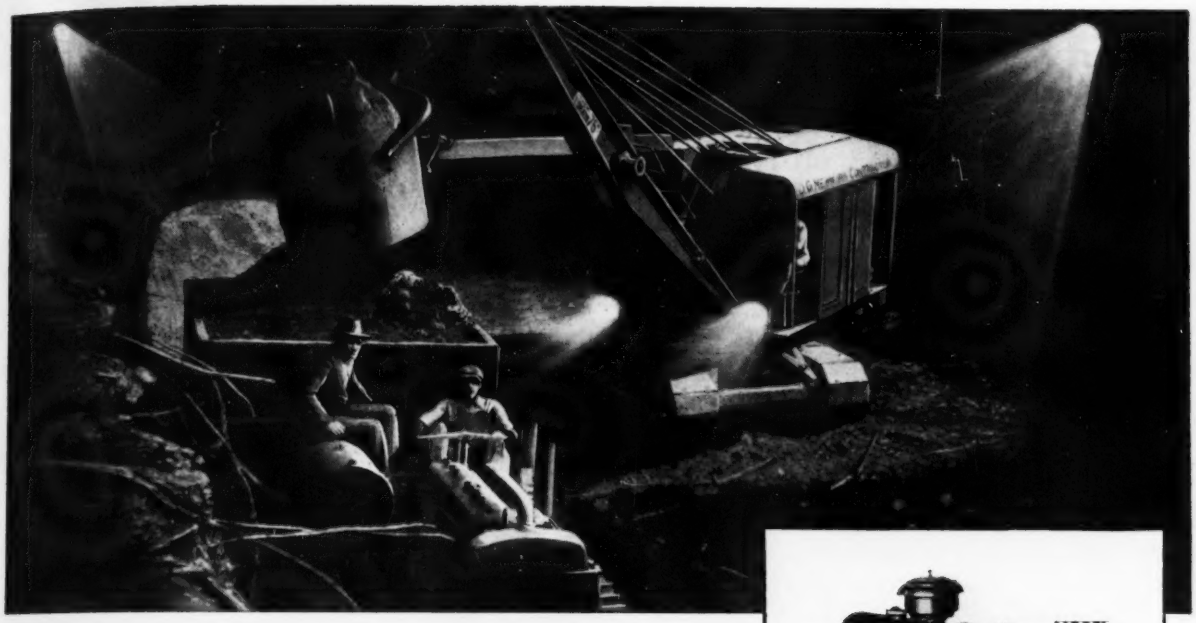
Col. DeWitt C. Jones, Norcross, Ga., formerly assistant to the president of the Mississippi River Commission at Vicksburg, Miss., has been designated by the War Department as district engineer at New Orleans, La.

C. B. Pendergraft, formerly office engineer in the Chief of Engineers Office of the Arkansas State Highway Department, has become an associate engineer in the Panama Canal Service.

R. A. Burch, of Fremont, N. C., resident engineer for the North C rolina State Highway and Public Works Commission, has resigned to accept a post at Wilmington, N. C., with the U. S. Army Engineers.

C. C. Davis, resident engineer for the U. S. Army Engineers at Gowen Field, Boise, Idaho, has returned to Portland, Ore. for duty with the district engineer's office there. He has been replaced at Boise by his assistant, **M. J. Vennewitz.**

R. H. Baldock, Oregon state highway engineer announces several changes in his department involving personnel. **Henry Hackett,** formerly personnel director, has been appointed engineer in charge of rights-of-way for the con-



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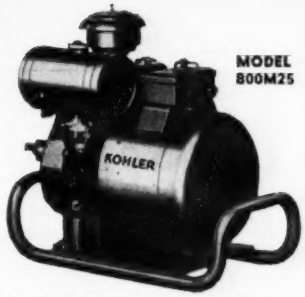
Depend on KOHLER Electric Plants for unfailing light and power —where and when needed

• These are times of all-out action! To this end, Kohler Plants are constantly busy — getting big things done better, saving precious work hours, beating previous job records.

Kohler Electric Plants are compact, rugged, efficient. Quickly installed on dredges, excavators, drag lines, pavers and other portable equipment...easily movable on small trucks . . . essential for flood-lighting night work in bridge and road building, plant construction, oil-well drilling and all types of war production. Also, they supply ample power for operating motors, pumps, compressors and small tools.

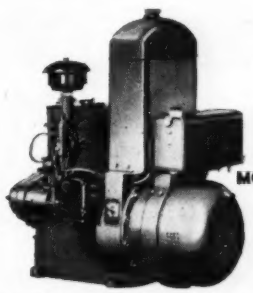
These are tested products — approved and improved over years of hard service under all conditions. They stand guard for emergency service, when regular current fails, in war plants, police departments, public utilities, hospitals and other vital centers. Thousands are in Government use—in virtually all branches of the service, on land and sea.

There are many models, types, sizes . . . 800 watts to 10 K.W. . . . A.C. or D.C. — hand cranked, remote control or fully automatic . . . $235 up. Write for special information for contractors and engineers. Kohler Co., Dept. ENR-2F, Kohler, Wisconsin.



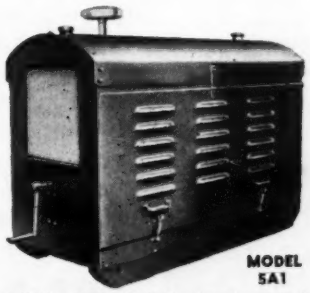
MODEL 800M25

800 watts, 115-volt A.C., hand cranked, with skid-type base and attached fuel tank for portable service. Also available fully automatic.



MODEL D

1500 watts, 110-volt D.C., fully automatic. Available hand cranked, with metal housing and skid-type base. Also in A.C. and 2000 watts D.C.



MODEL 5A1

5 K.W., 120-volt D.C., hand cranked, with metal housing and skid-type base. Also 10 K.W., 5 K.V.A., and 10 K.V.A., 60 cycle, A.C., fully automatic or remote control.

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PLANNED PLUMBING AND HEATING

Equipped as a CONCRETE VIBRATOR

Wipe Out

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On 9 EVERY-DAY JOBS

with A Mall TRADE MARK Gasoline Driven POWER UNIT

We Make Over **200** Gasoline Engine Air and Electrically Operated Portable Power Tools and Attachments

• Use it for Concrete Vibrating, Concrete Surfacing, Form Sanding, Sawing with Circular or Chain Saw, Wire Brushing, Grinding, Drilling in Wood, Brick, Steel or Stone, Pumping and Sharpening Tools.

Any contractor can save enough time, labor and material with this 3 H. P., Gasoline-Driven Power Unit to absorb its cost on the first few jobs. It's by far the most useful tool you could own. It can be operated in the most remote places . . . can be wheeled anywhere on the job . . . runs all day on 1½ to 2 gallons of gasoline. It is easy to start in cold weather and requires little attention. Interchangeable tools for the 9 every-day jobs listed above can be changed as quickly and easily as bits in a brace.

With a scarcity of time, labor and materials facing you in 1942 get the facts on this 9-job Power Unit TODAY. Plan now to motorize these manual time-consuming tasks and avoid overtime—lost motion and wasted material. A FREE Demonstration is yours for the asking—Write AT ONCE for our 1942 Catalog and Prices.

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Smith Water Works Equipment is being installed in Airports, Ordnance Plants, Munitions Plants—on the job in this War just as it was in the last. There's no time for trouble with Water Works Equipment now—or at any time—so Smith is still furnishing dependable Valves, Hydrants and other items

You may not be able to get SMITH Equipment as quickly as in the past—but we are making every effort to take care of our customers and you CAN get our Catalog and study and plan for the future. Write us today.

THE A. P. SMITH MFG. CO.

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7 So. Dearborn St., Chicago, Ill. 409 Texas St., El Paso, Texas 315 N. Crescent St., Flandreau, S. D. 901 Wm. Oliver Bldg., Atlanta, Ga. 59 Oak Vale Ave., Berkeley, Calif. 524½ First Ave. S., Seattle, Wash.

struction division and personnel director for that division; **Paul van Scoy** was transferred to eastern Oregon as division engineer and **Ray Weber** succeeded Van Scoy as assistant construction engineer.

Herbert O. Lord, formerly chief engineer of the Madison, Wis. Metropolitan Sewerage District, is on active duty as a lieutenant-commander in the Civil Engineer Corps of the U. S. Naval Reserve at Twelfth Naval District headquarters, San Francisco.

A. J. Hawkins, former city engineer of Birmingham, Ala. and a director of the Alabama State Planning Commission, has been appointed assistant to **Richard H. Lyle,** regional director of defense, health and welfare services. Mr. Hawkins' territory will be six southern states.

John D. Morris, division engineer of the Philadelphia terminal Division of the Pennsylvania Railroad, has been promoted to the post of superintendent of the Wilkes-Barre Division, making his new headquarters at Scranton, Pa.

Maj. Francis H. Oxx, executive assistant to **Lt. Col. A. M. Nielson,** district engineer of the U. S. Engineers at Kansas City, Mo., has recently been advanced to the rank of Lieutenant Colonel.

George Meyer, recently assistant to the engineer of road design of the Texas State Highway Department, has been ordered to active duty as a first lieutenant in the Army Engineering Reserve Corps.

Hugo E. Bothe, designing engineer of the Kenosha, Wis. park department since 1933, has been appointed chief of the building inspection department for the city of Kenosha, succeeding **R. L. Petersen,** who resigned to enter private work.

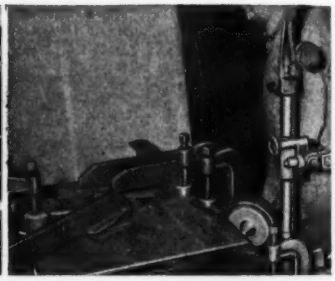
John Sullivan, city engineer at Meade, Kansas, has resigned the post to accept a position as county engineer for Haskell County, Kan., with headquarters at Sublette.

E. W. Dunn, district engineer for the Iowa State Highway Commission at Sioux City, has returned to his post after a year's leave of absence during which he was project engineer on the construction of Fort Leonard Wood, Missouri.

G. M. Ridenour, formerly associated with the department of water and sewage research for the New Jersey Agricultural Experiment Station, and recently an associate professor in sanitary engineering at Pennsylvania State College, has become an associate resident

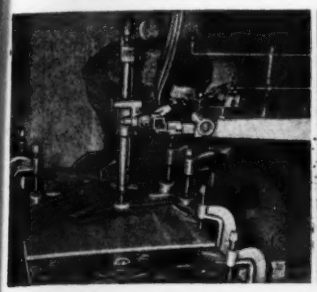
How OXY-ACETYLENE STACK-CUTTING Saves Shaping, Machining, and Assembly Time

1. Steel is stacked and routed to the Oxweld flame-cutting machine as soon as it comes into the plant. It is cleaned and the edges evened up. Using a sheet metal templet as a guide, the shapes to be cut are then marked off in chalk. This "layout" assures minimum scrap.

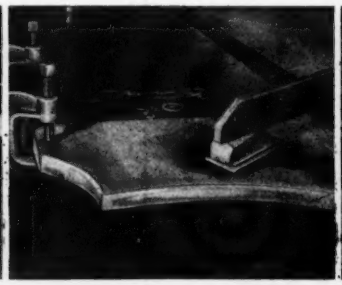


2. Clamps are applied to hold the stacked steel tightly together—which is the main factor in successful stack-cutting. The operator then grinds the edge of the stack where the oxy-acetylene blowpipe is to begin the cut, as this helps assure a clean, square, starting cut.

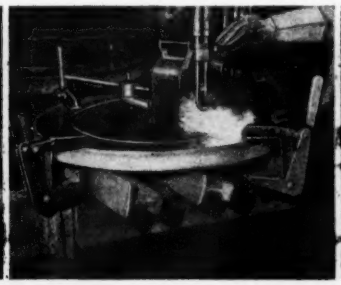
In the fabrication of parts for the concrete mixers which they manufacture, T. L. Smith Company (Milwaukee, Wisconsin) uses oxy-acetylene stack-cutting extensively. This is done because stack-cutting produces parts of identical size and shape—which facilitates assembly and helps make a more uniform product—and also because flame-shaping speeds up production and lowers fabricating costs, as compared to the shearing method formerly used. Stack-cutting helps conserve steel, too, because it reduces scrap losses. Another important advantage is a substantial saving in subsequent machining operations.



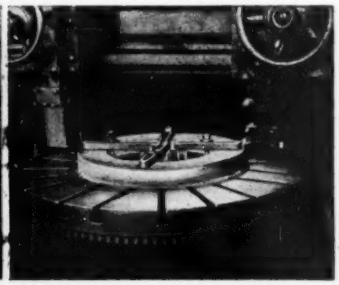
3. The cutting starts. The blowpipe is guided along the contours by templets which the tracing unit of the Oxweld machine follows. In this view, a stack of 25 sheets of 18 gauge steel is cut.



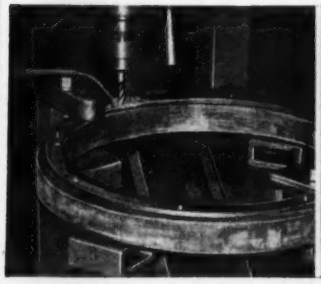
4. The cut edge of the stack is smooth and even. A ¼-in. waster plate on top helps assure clean, square-cut edges on all the sheets in the stack. Oxweld nozzles cut rapidly, with minimum kerf.



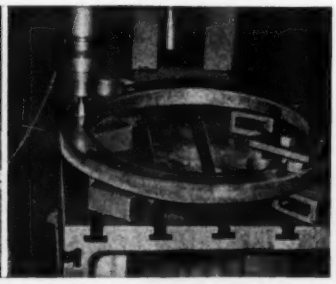
5. In this view, a portable Oxweld machine is flame-cutting a stack of rings. Notice the quick-acting clamps which hold the stacked steel tightly together, assuring uniformly clean and square cuts.



6. The entire stack of flame-cut rings is then set up on a boring mill for "stack-machining" of the edges. It is here and in machining operations to follow that the *extra* savings really begin to show.



7. Next, the stack of rings is drilled — again with substantial savings in time and cost as compared to the drilling of single parts which was necessary when the parts were shaped by shearing.



8. Finally, the holes are "stack-tapped." T. L. Smith engineers estimate that there are sufficient savings in the stack-machining operations alone to pay the entire cost of the flame-shaping operation.

Linde Can Help You Use it!

If you would like to know more about using oxy-acetylene stack-cutting in your business, get in touch with Linde. Linde can supply the gases, the apparatus, and on-the-job help in using these processes profitably. Write or phone the Linde office nearest you for complete information.

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lecturer in public health engineering at the School of Public Health at the University of Michigan.

William H. Hall, assistant city engineer at Oklahoma City, Okla., has resigned to join the teaching staff of Oklahoma A. & M. College at Stillwater, Okla.

Herbert Fritz, maintenance engineer for the public schools at Burlington, Iowa, recently resigned and now holds the position of associate engineer to the Construction Quartermaster of the seventh zone, with headquarters at Omaha, Nebr.

Walter Anderson, formerly WPA superintendent for Richland County, Montana, has joined the Tennessee Valley Authority as an inspector of construction work on the Nottely Dam near Murphy, N. C.

James N. Martin, for 45 years an engineer on the staff in the Pittsburgh office of the U. S. Engineers, has become head administrative assistant to **Col. D. Lee Hooper,** district engineer.

O. H. LeBlanc, formerly general manager of the St. Mary Iron Works, Franklin, La., and **John H. Long,** former chief engineer with the same company, have resigned to open offices at Beaumont, Tex., under the name of LeBlanc & Long. The firm will practice structural engineering.

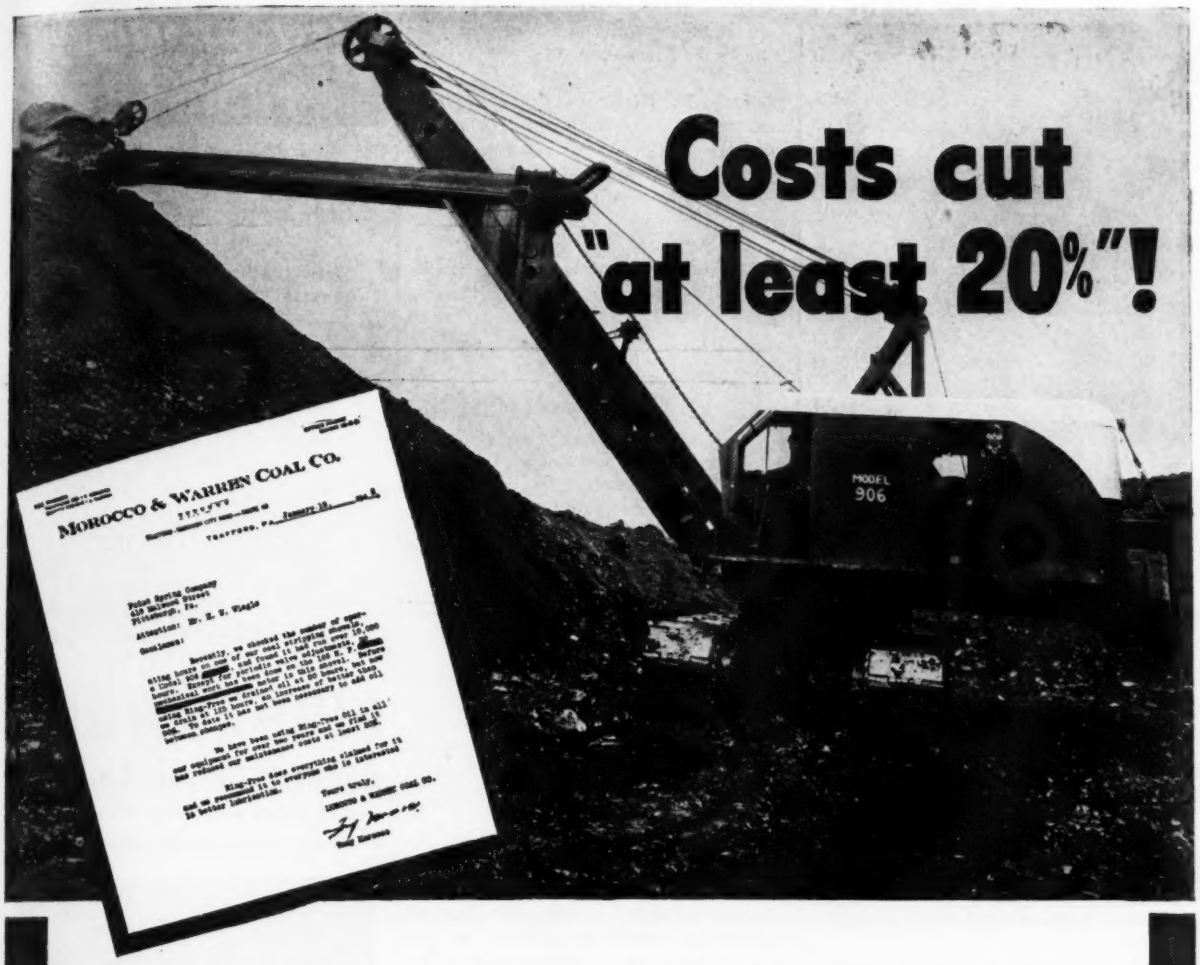
Harold Rowley, of Everett, Wash., has become maintenance engineer of the district engineer's office of the Washington State Highway Department. He was formerly maintenance supervisor for the highway department at Everett.

T. C. Forrest, Jr., of the consulting engineering firm of Rollins & Forest, Dallas, Tex., has been named resident engineer at Denison, Tex. in charge of a survey to be made there for the construction of a 35,000-man army camp. He will be assisted by **J. D. Mahoney,** chief office engineer; **V. H. Thomas,** mechanical engineer; **H. E. Sanders,** electrical engineer; **S. A. Fowler,** engineer on roads and drainage, and **L. D. Matter,** water and sewer engineer.

Linus Roth, of Hays, Kan., county engineer for Ellis County, has resigned to become county engineer for Trego County, making his headquarters at Wakeeney.

W. H. Poston, formerly of the Iowa State Department of Public Health, has become assistant superintendent of the waterworks at Ottumwa, Iowa.

Martin L. Dowell, Jr., associate engineer of the Arkansas Ordnance Works, Jacksonville, Ark., has been promoted to



"WE HAVE been using RING-FREE in all our equipment for over two years," writes the Morocco & Warren Coal Company of Trafford, Pennsylvania, "and we find it has reduced our maintenance costs at least 20%."

Recently they checked a Model 906 coal stripping shovel and found it had run over 10,000 hours with only periodic valve adjustments on the 165 H. P. motor.

"Before using RING-FREE we drained oil at 80 hours, but now we drain it at 125 hours, an increase of better than 50%. To date it has not been necessary to add oil between changes."

Then Tony Morocco adds:

"RING-FREE does everything claimed for it and we recommend it to anyone who is interested in better lubrication."

RING-FREE is the *only* oil you need for gasoline engines or Diesels. Think *how* that simplifies your lubricating work!

What RING-FREE has done for others it can do for you. Won't you write us?

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MOTOR OIL

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WATER
FOR A NATION AT WAR!

To the East and to the West, we are looking straight into the cannons of war. From within we face the inevitable saboteur. It is time to become grim, cautious and determined in our war aims and actions. We must win this war and do a good job of it. We will fight with men, metals, fuel, power, food, water and materials of all kinds.

Never before has water been a more vital necessity. Beyond its task of serving men, materials and machines, water now also must guard against fire . . . protect factories, equipment, supplies, homes . . . and lives.

As in the strenuous days of defense preparation, Layne now is ready, fully equipped and speedily engaged in an even greater task . . . that of providing water for a Nation at war. This activity includes service to the Military and Naval forces, essential industries and necessary repair work.

Check your water supply and install necessary wells and pumps. See that all present wells and mechanical equipment are placed in good order and kept ready for any emergency. Repairs to existing equipment will conserve material needed for war purposes.

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Layne-New York Co.	New York City.
Layne-Northwest Company	Milwaukee, Wis.
Layne-Ohio Company	Columbus, Ohio
Layne-Texas Company	Houston, Texas.
Layne-Western Company	Kansas City, Mo.
Layne-Western Co. of Minn.	Minneapolis, Minn.
Layne-Bowler New England Corp.	Boston, Mass.
International Water Supply, Ltd.	London, Ont.

WORLD'S LARGEST WATER DEVELOPERS

area engineer with offices at the Pine Bluff, Ark. Arsenal.

Thomas W. Bivins, sanitary engineer with the Pitt County health department at Greenville, N. C., has become sanitary engineer and inspector for the Guilford County health department at Greensboro, N. C.

Gen. Wilmot A. Danielson, until recently acting district engineer of the Panama District, U. S. Engineers, has assumed command of the general depot at Memphis, Tenn.

Ralph O. Spofford, of Marblehead, Mass., has been appointed acting bridge engineer in the Massachusetts department of public works. He will succeed **George E. Harkness,** retired.

Walter C. Hogenson, of Rochester, Minn., has been appointed city engineer for Moorhead, Minn.

J. S. Gena, of New Philadelphia, Ohio, assistant chief engineer for the Muskingum Watershed Conservancy District, has been appointed engineer for the War Products Cooperative, a manufacturers' organization in nine counties in the New Philadelphia area.

D. D. Whitson, plan examiner for the department of buildings of the City of Toronto, Canada, has taken a leave of absence to serve in Ottawa with the Works and Buildings Branch of the Naval Service in the Department of National Defense.

Ed Clipston, former engineer at the Shenandoah, Iowa, city waterworks, has been named city water commissioner there. He replaces **Melvin Totten,** who signed after 16 years of service.

William E. Hawkins, of Raleigh, N. C., has been appointed state construction engineer for the North Carolina State Highway and Public Works Commission.

R. C. McLane, who has been field engineer with the utilities division, Brooksfield, Tex., military reservation for the past two years, has been transferred to the utilities division, Harlingan airbase, Harlingen, Tex., as associate engineer.

Earl Johnson, office engineer in the city of Wauwatosa, Wis., engineering office, has accepted a post in the designing department of the War Department's engineering office in Chicago, Ill.

E. F. Baker, Creston, Iowa, formerly county engineer for Union County, has gone to Monterrey, Mexico, to become construction engineer on the building of five airports for American Airlines.

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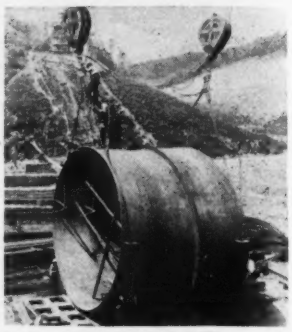

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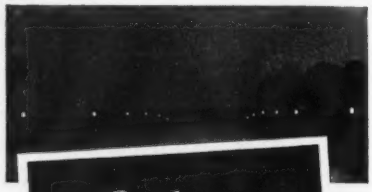
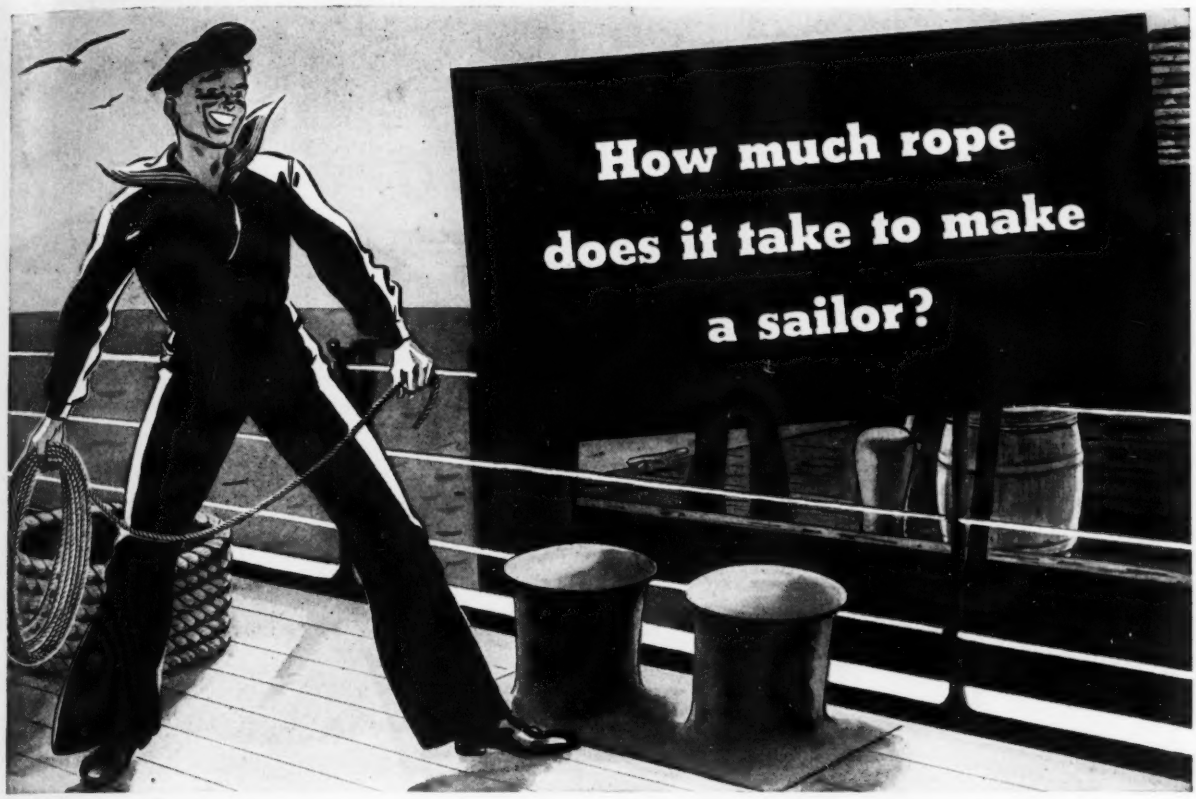


Taking a safety tip from the nation's highways . . . where Cataphote Reflectorized Signs and roadway delineators are widely used . . . more and more industrial and construction men are finding these Reflectors the ideal answer to their safety problems today. Cataphotes offer **proven reflecting performance and permanence** for marking danger points in Defense Camps, Defense Plants . . . also for safer roads, streets, bridges and industrial plant traffic handling. Write for more facts.

WESTERN CATAPHOTE CORP. • TOLEDO, OHIO



ANSWER: If you also include soldiers, marines, and the 17 workers required to equip every single armed man . . . the answer is: All the Manila rope this country can produce.

REMEMBER PEARL HARBOR?
That infamous attack which started War in the Pacific also interrupted normal trade movements of one of Uncle Sam's vital materials: Manila fiber from the Philippines.

The Government has wisely diverted all existing stocks of Manila fiber to production of rope for war, leaving civilian needs to be filled by rope made from other fibers.

PLYMOUTH WARTIME ROPE has been made to fill civilian orders. Composed of the finest sisalana fibers available, it is approximately 80% as strong as our famous Plymouth Ship Brand Manila.

WARTIME Rope, too, must be conserved to the best of our ability. There's no rope to waste, of any kind.

MAKE IT LAST LONGER. If every piece of rope used in 1942 were made to last 10% longer through proper care and handling, the country's stockpile would be increased by 15,000,000 pounds.

HERE'S ONE BIG WAY YOU CAN HELP OUR WAR EFFORT: Plant Engineers, Superintendents, Foremen, and all other "bosses" can instruct their men to take better care of *all rope*. A few simple rules, if carried out, are sufficient.

FOR INSTANCE, rope should be stored in a dry, unheated place with free air circulation, to prevent dry rot. Rope loads should be estimated on the Plymouth Tensile Strength Table to prevent overloading and breakage. This is very important now, since the Wartime brand has approximately 80% the tensile strength of Plymouth Manila.

SO PLAY SAFE, BE THRIFTY, HELP UNCLE SAM WIN. For complete information on rope conservation, send the coupon in for a free book telling you how to make rope last longer.

PLYMOUTH
THE *Rope* YOU CAN TRUST
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You may send me a copy of your new free book, "MAKING ROPE LAST LONGER."

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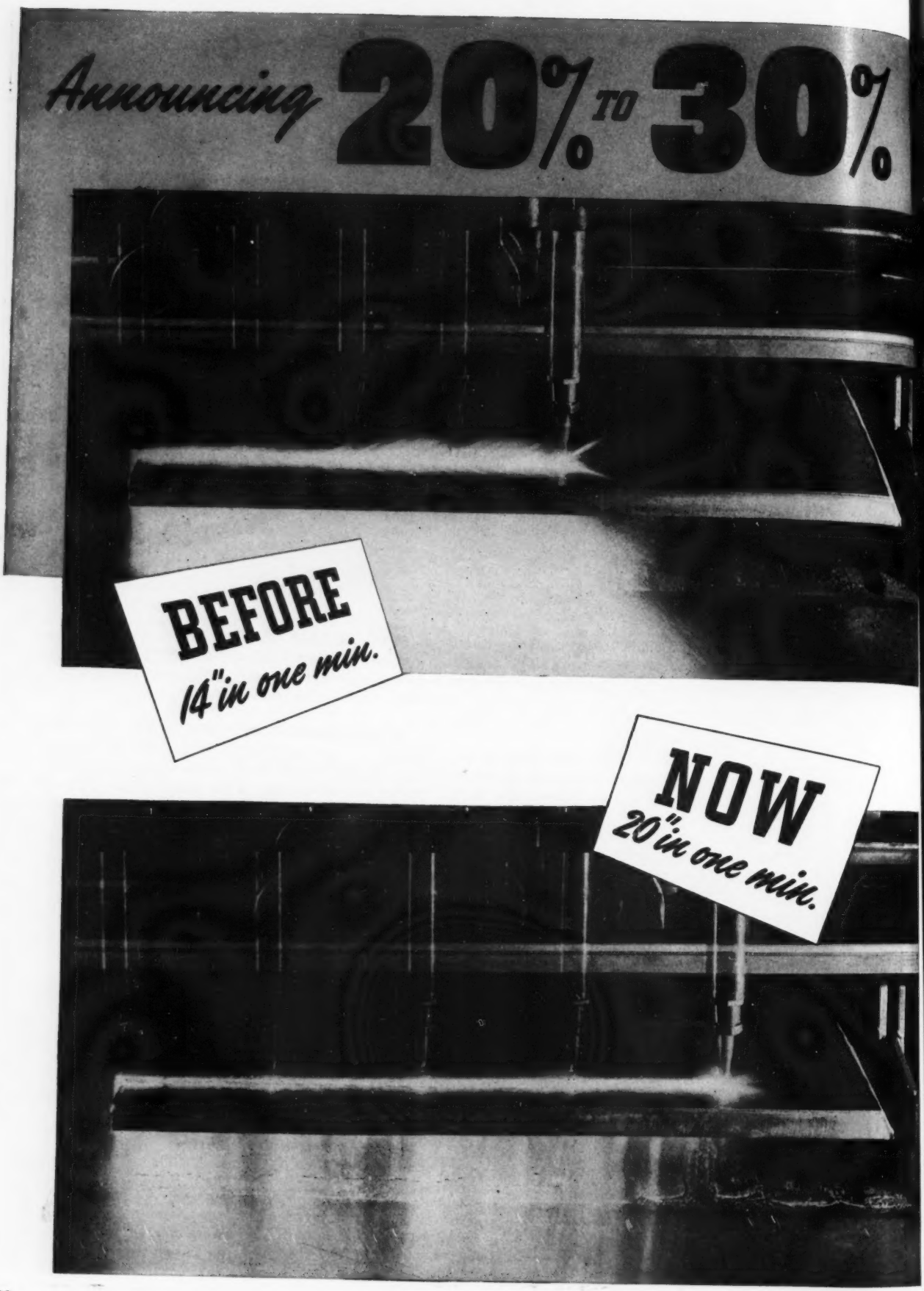
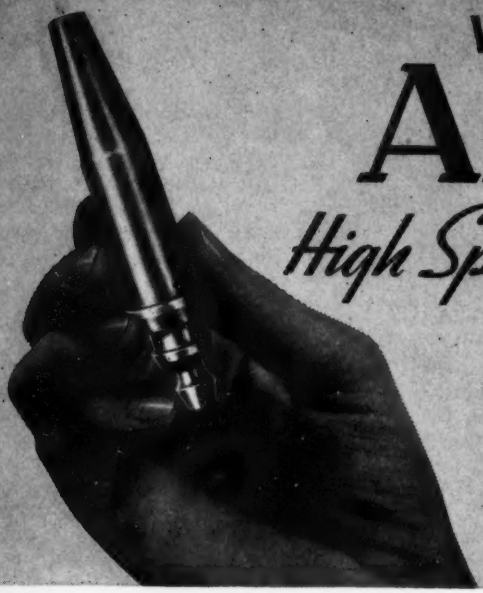

Announcing 20% TO 30%
BEFORE
14" in one min.
NOW
20" in one min.

FASTER CUTTING SPEEDS

WITH THE NEW Airco "45"

High Speed MACHINE CUTTING TIP*



. . . A PRECISION TOOL GEARED TO THE DEMAND FOR HIGH PRODUCTION

IN hundreds of field tests, the Airco "45" has demonstrated its capacity to greatly increase production by decreasing the time required to cut metal up to eight inches thick by 20% to 30%.

The Airco "45" High Speed Machine Cutting Tip has a nozzle with a divergent exit portion—a design that permits a narrow, high velocity stream of oxygen, practically free of exit turbulence. A stream of oxygen from the Airco "45" burns away a narrower cut, or kerf, of metal than the conventional tip. As a result of cutting away less metal, the tip cuts faster, precisely and more economically.

Airco "45" High Speed Machine Cutting Tips are at present available in sizes to cut metal thicknesses up to 8 inches. To obtain full value they should be used on oxygen pressures of 85 psi or higher. By substituting a High Speed Tip for the conventional tip in your machine cutting torch you save precious production hours.

*Method Patent No. 1985080

AIRCO

An interesting booklet points out the many advantages that are yours with Airco "45" Tips. Write on your company letterhead for a copy today.

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Anything and Everything for GAS WELDING or CUTTING and ARC WELDING

ASSURING SATISFACTORY OPERATION

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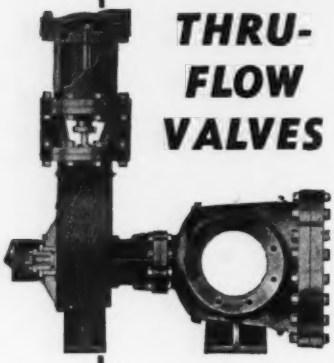
GOLDEN-ANDERSON

CONE THRU-FLOW VALVES



On many automatic operating services — altitude, reducing, check, relief, emergency shut-off, etc. . . . . G-A Cone Thru-Flow Valves assure a high degree of satisfactory operation . . . assure a full line opening without pressure drop. Both in design and construction, these valves represent the soundest engineering principles. Their low-operating cost record on varied installations throughout the country, recommends their selection for lines now going in, or replacement lines.

In lieu of gate valves, these G-A Cone Valves can be supplied manually operated. Sizes from 4" to 72".

Here is another in the complete selection of GOLDEN-ANDERSON automatic steam and water service valves. For further details on this valve, and others of the entire G-A line, write for data. CHOOSE G-A, AND SAVE!!

GOLDEN-ANDERSON VALVE SPECIALTY CO.
FULTON BLDG.
PITTSBURGH . . . PENNA.

New Aids to the Constructor

Equipment and material announcements and manufacturers' news

Open End V-Belting

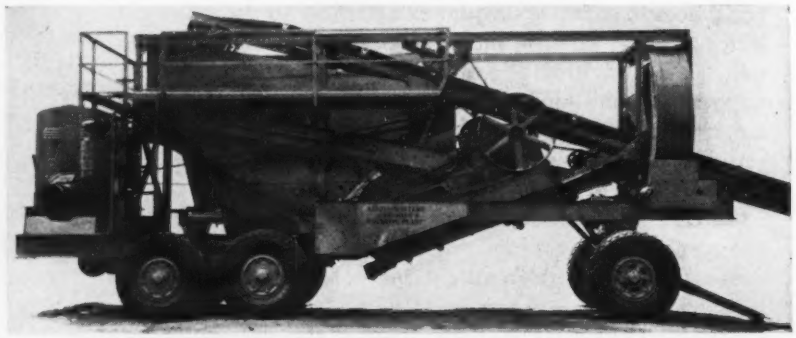
A new departure in power transmission is open end V-belting now available for drives where application of endless V-belts is not practical. Open end belting differs in construction from the endless V-belt in that the strength member consists of multiple plies of heavy cross woven duck which provides adequate anchorage for metal fasteners. A new catalog section describing this material is available upon request.—*B. F. Goodrich Co., Akron, Ohio.*

Blackout Paint

A blackout paint for use in darkening windows and skylights of industrial and commercial properties has been announced by American-Marietta Co. The paint is being marketed in paste form and, when cut 50 percent with water, can be sprayed or brushed on windows to prevent all passage of light. It covers 800 sq.ft. to the gallon and dries within 40 min., providing a flat surface that will not flash back or glare. In interior applications, a single coat may be covered with a white paint where large glass surfaces make the higher reflection properties of a white surface necessary.—*American Marietta Co., 43 East Ohio St., Chicago.*

Rust Preventative

A new product, Aqua-Clear, is said to prevent rust and provide clear water from any metal tanks or pipes and to also clear out loose rust from old containers. Rust formation is prevented by the deposit of a thin, non-permanent film on metal surfaces. This product is a clear, tasteless, harmless liquid which is added in minute quantities to the water as it is put into the system. The amount required to prevent rust is one ounce to each 100 gallons of water. This film is so thin that it does not interfere with the flow of water, even in narrow pipes, and it cannot build up to form a scale. —*Sudbury Laboratory, South Sudbury, Mass.*



Austin-Western Twin Unit Crushing Plant

Recently placed on the market is a highly portable double-unit crushing plant capable of delivering exceptionally large outputs of crushed gravel or stone. The reduction unit is suited equally well for gravel or for quarry service and consists of a 4022 all roller bearing roll crusher, 4x12 ft. triple deck gyrating screen and rotary return elevator all mounted on a six-wheel, pneumatic tired truck equipped with 30 in. feed and delivery conveyors. The primary unit which is used ahead of the secondary unit for gravel service, normally consists of a 1036 jaw crusher with scalping screen mounted on a truck with a feed conveyor; for quarry service a large opening jaw crusher with apron type feeder is used. The outfit has a weight of 39,000 lb. with an overall width of 8 ft. and overall height when operating of 13 ft. The use of the two units provides a flexible arrangement, capable of meeting the various material specification from local deposits; it also permits all parts to be readily accessible.—*Austin-Western Road Machinery Co., Aurora, Ill.*

OSGOOD

Type 80, Model 800 Air-Control Shovel owned by Joseph Grisafe of Warren Point, N. J. Air-Control is equally effective on shovel, dragline or crane work.

AIR CONTROL SMOOTH AS STEAM?

Well, old time operators—who ought to know—say it is. Just as easy to handle—and quite as important—it's just as dependable.

Write for our new illustrated Air-Control Catalog

The **GENERAL** EXCAVATOR CO

Sizes:
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Associated with THE OSGOOD CO.

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HERCULES
IRONEROLLERS
6 to 12 Tons
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Diesel-Oil-Gas-Electric

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SHOVELS
DRAGLINES - CRANES
Crawler & Wheel Mounted

THE OSGOOD COMPANY, Marion, Ohio

Brewster Airport...

Seaman Pulvi-Mixer powered by a Model 6MZR Waukesha Power Unit

A DEFENSE CONSTRUCTION **miracle**

Paving 5800 lin. ft. of Runways

100 ft. wide in 8 days with the help of Waukesha Power

More *Buccaneer* and *Bermuda* dive bombers! This demand means a new factory to make them. And a new airport, with paved runways, to test them . . . an airport that normally takes a year to build. Brewster Aeronautical Corp. couldn't wait that long.

By substituting soil-cement runways for the conventional macadam or concrete, the airport was built at Johnsville, Pa., in four months—at less than half the normal cost.

And Waukesha Power . . . always a vital factor in construction . . . has helped to work another defense miracle.

Special machines, like the one shown here, were used by the contractors, D. W. Winkelman & Co. of Syracuse, N. Y. These Waukesha-powered Seaman Pulvi-Mixers mix in 15% Portland cement while pulverizing the soil. Then, after power spraying with water, they mix the water with the cement soil combination.

Mounted directly on a rotor shaft . . . and driven at great velocity by the Model 6 MZR Waukesha self-contained Power Unit . . . the mixer tines dig into the material, creating a virtual tornado. Hurled against the hood-housing at 90 miles an hour, the materials are mixed with remarkable rapidity and thoroughness.

Actual laying of the runways, start to finish, took only eight 24-hr. days. Waukesha-powered equipment is the kind you *can* push 24 hours a day. Waukesha Gasoline and Oil Engines for Industrial, Stationary and Automotive Power range in size from 5 hp. to over 300 hp. *Get Bulletin 1079.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
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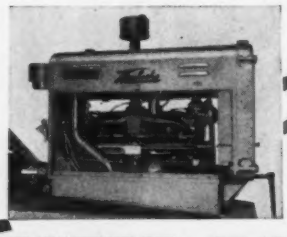
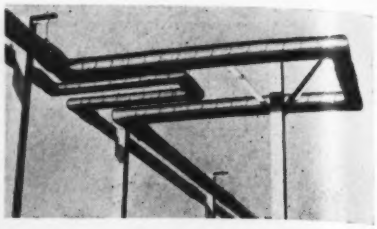


MORE POWER FOR DEFENSE

WAUKESHA ENGINES



Pre-Insulated Steam Line

Ric-wiL's factory prefabricated insulated pipe units are brought to the job ready to hoist into place and fulfill every essential and practical requirement for speedy, trouble-free and economical installation. Several of the units can be welded together on the ground and the welded sections then hoisted into position, eliminating the need of handling single units and doing the welding overhead.—*Ric-wiL Co., Cleveland, Ohio.*

Enameled Roofing and Siding

Porcelok is a porcelain enameled corrugated roofing and siding available in 24-in. wide and up to 12 ft. long sheets. The sheets are available in many colors and are supplied completely engineered to fit every job. Porcelok is erected from the outside only, requiring no inside scaffolding and, because of the unique interlocking design, all fastenings are completely covered by the adjacent sheets. Porcelok requires little or no maintenance and never requires painting.—*Porcelok Co., Division of Davidson Enamel Co., Clyde, Ohio.*

Jackets for Wood Piles

Wood piles as badly disintegrated from marine borers or other action as the one above have been saved by inclosing them in the reinforced concrete jacket placed by the Dens-Hard method. The piles are first cleaned and repaired across a disintegrated section by the use of long staples and then encased in a wire mesh basket. The concrete form is then put around the pile extending to the mud line of the piles, and this is

MANASITE—the Detonator of Tomorrow—Available Today

Greater Safety *plus* Dependable Performance Helps to Increase Production

Safety, today, is more vital than ever. Every accident means an irreplaceable loss not only of man-hours but of machine-hours—a serious cut in the effectiveness of the country's production equipment.

Inadvertent mishandling of explosives and detonators is more probable today—both because of the many new men being put on, and because of the rush for production.

By helping to avoid such accidents, Atlas Manasite Detonators are doing their part to increase production.

Atlas Manasite is the result of years of experience in making blasting caps. Before Manasite was introduced, Atlas made hundreds of millions of detonators—good detonators, as reliable and as relatively safe as any produced at the time. Then, through chemical research, Atlas changed the blasting-cap picture. With Manasite, an exclusive method of manufacture—plus the use of hexanitromannite as a detonating agent—substantially increased the margin of safety. While no blasting cap can be called "safe," Atlas Manasite Detonators make safety precautions more effective than ever.

Today, with increased production a "must," can you afford to overlook this advance in safer blasting?

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Arkwright Standards STAND!

As industry rushes to its battle stations, it can be sure that its designers and draftsmen will continue to have good quality tracing cloth to work with.

For Arkwright standards stand . . in war as well as peace!

In 1939 Arkwright standards – smooth, smudge-proof surface and permanently transparent finish – meant a good deal to draftsmen working on consumer goods production. But think how much more essential they are in 1942 as industry speeds up its war supplies output.

Besides maintaining the quality of its tracing cloths, Arkwright also maintains sufficient stock to assure dependable delivery to defense and non-defense industries. Write for samples and new catalog. Arkwright Finishing Co., Providence, Rhode Island.

Arkwright TRACING CLOTHS

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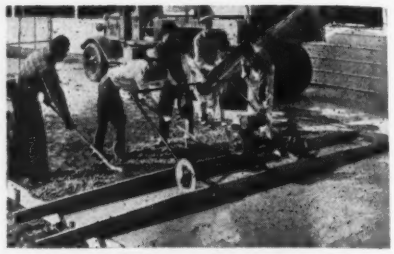
filled with concrete designed to give extreme density, hardness and durability with a minimum of porosity and without the concrete coming in contact with salt water. The Dens-Hard form seals and centers itself on any part of the pile. All work is done above the water line, the rise and fall of the tide being prevented from interfering with the jacketing operation.

A toxic-refill method has also been developed to force a pre-determined amount of fresh creosote into creosoted wood piles which have had some of their original material leach out. This refill kills the borers that may be in the pile and prevents new ones from attacking the pile.—*The Pile Protection Co., P. O. Box 634, Journal Square Station, Jersey City, N. J.*



Paving Screed

A power-driven screed for concrete paving, indoors or out, is said to enable one man to handle 4 cu. yd. of low-slump concrete in 5 minutes. Driven by a Wisconsin 2.3-hp. air-cooled gasoline engine, the two screeds of this machine make 5-in. transverse strokes in opposite directions. During this movement, the screeds move forward uniformly under the pull of the operator. Vertical discs steady the machine in its proper position and prevent it from moving transversely with the screeds.

The discs are adjustable so they will sink to the desired depth in the concrete; they relieve the screeds of some of the weight and serve as wheels when the machine leaves the work. The machine weighs 235 lb. without screeds which are readily detachable. Best results are claimed for 2x6-in. screeds tapered at the ends and shod with angle iron. The levelling and vibrating action is said to make it easy for one man to screed very dry concrete in less time than would be required for hand screeding.—*Whiteman Mfg. Co., 3249 Casitas Ave., Los Angeles.*

Asphalt Protected Steel Sheet

A new product known as A-P-S is an asphalt protected steel sheet for roofing and siding in industrial construction. It

If you need CULVERT PIPE *in a hurry . . .*

. . . write, telegraph, or telephone the nearest Lock Joint Plant listed below. Large stocks of Lock Joint Culvert, Drain and Sewer Pipe are maintained at and are ready for immediate shipment from these ten strategically located points.

Nowadays the password is speed . . . speed of delivery. The Lock Joint Pipe Company is prepared to make immediate shipment of reinforced concrete pipe from its permanent plants — and is further prepared to set up on the site of important projects temporary manufacturing units for the purpose of speeding up pipe delivery, thus enabling vital defense projects to meet short completion schedules . . . a factor of great strategic importance in these days.

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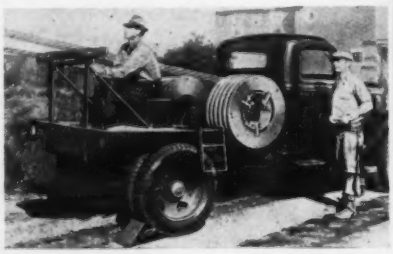
is uniformly coated on both sides with a special composition coating said to give extreme durability and protection against the extreme range of weather conditions as well as against acid fumes and gases. It has the advantage of economy of maintenance as it requires no paint or other finish. It is adapted to the speedy erection of new plants and for quick remodeling of all structures. Produced by the Protected Steel Products Co. of Pittsburgh, it will be distributed by—*Levinson Steel Sales Co., 33 Pride St., Pittsburgh.*

Typewriter for Tracings

The Vari-Typer, heretofore an office machine, has been redesigned for use in lettering specifications and plans with any of several changeable type faces. The machine can handle tracing cloth or tracing paper up to 12 ft. in length with almost any type face desired.—*Ralph C. Coxhead Corp., 333 Sixth Ave., New York City.*



Wire Reclaiming Winch

A wire reclaiming winch which will reclaim all sizes of copper and iron telephone wires from poles, is said to be able to coil ten wires, each a mile long, at the same time at a speed of 150 ft. per minute and the reclaimed coils of wire are nearly as perfect as original factory coils of new wire. The winch is a power-driven worm geared unit, having worm gear sets of special pitch thread to give proper wire speed. The winch is entirely controlled from the rear of the truck by two levers, one for releasing the engine clutch and the other for operating the power take-off. Whenever small quantities of wire are to be reclaimed, a five-wire detachable reclaiming reel unit may be used, slipped on the

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Why?

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THE gripping unit in an Electroline-Fiege Wire Rope Connector holds like a Bulldog because it has a "Positive Grip". The holding compression is graduated from front to rear so that danger of crystallization, due to vibrations, is eliminated. Frayed strands and early failures are avoided.

Many other advantages, such as greatly increased wire rope life, elimination of hazards to workmen, etc., have made these connectors first choice for dependable results. Let us send you an interesting booklet, "Positive Grip". It will give you complete performance data on this easily installed, better and more economical streamlined connector. Write today.

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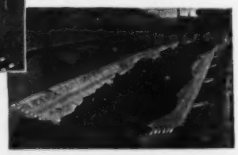
Electroline Company

4004 South La Salle Street Chicago, Illinois

KEEP YOUR CONVEYOR BELTS GOING



FLEXCO H D RIP PLATES are used in repairing rips and patching conveyor belts. Their use saves expensive replacements and extended shutdowns.

FLEXCO H D BELT FASTENERS make a strong, tight butt joint with long life. Recessed plates embed in belt, compress belt ends and prevent ply separation. Six sizes in steel and alloys.

● Avoid shutdowns and lengthen the life of your conveyor belts and bucket elevator belts by using Flexco belt fasteners. Thousands of companies have stepped up the performance of conveyor lines and cut costs by using Flexco methods.

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Be Prepared for Air Raids

WITH —Carey— BLACKOUT PRODUCTS

These Scientifically Developed Products Provide Maximum Protection to Property and Personnel

A blackout, to be fully effective, must guard against two definite conditions—prevent reflection of outside light—provide protection against flying glass. Carey Blackout Products ideally meet both of these requirements.

Civilian Defense Bulletin says: **"A factory may be well blacked out, but its glass windows may reflect the light of moon, stars, fires or flares." The practical answer to this problem is to apply Carey Blackout Coating to outside surfaces of all skylights. This coating is non-reflective and insures complete light stoppage with one coat.**

Civilian Defense Bulletin says further: **"More injuries from flying glass are to be expected than from bombs or bomb fragments." Guard against this danger by applying any one of the three types of Carey Blackout Board to the inside of windows. Boards are rigid; cut to size; easily installed; quickly removable.**

Carey Blackout Products are economical and effective because they are specifically designed for blackout use. Proved right by tests. Write today for prices and details. Address Dept. 30.

BLACKOUT COATING—For indoor or outdoor application. Will last indefinitely inside and give upwards of two years satisfactory service outside. Inexpensive; easily applied with large brush, or may be sprayed on; quick drying. Covering capacity 350-400 sq.ft. per gallon. Easily washed off with naphtha, benzol or other solvents.

BLACKOUT BOARDS—Laminated asphaltic boards of good rigidity for removable panel installation. Moisture and condensation proof. Boards are easily cut to shape and size.

ALL-PURPOSE TREATMENT—Where a more permanent, weather proof, or exterior treatment is desired, use the Carey Laminated System. Apply a thick film of

Careyclad Coating and embed 30-lb. Carey Feltex (or Carey Asphalt Saturated fabric membrane) topping with a finish of Careyclad Coating. This provides complete Blackout and renders the glass shatter-proof.

BLACKOUT PAPER — Always keep several rolls of Carey Blackout Paper on hand for quick, temporary repairs. For best results, use a light weight Carey Smooth

Roll Roofing or the less expensive Carey No. 7 FibreWove, a tough asphalt saturated and coated building paper, weighing only 20 lbs. per 100 sq. ft.

REJUVO SYSTEM OF CAMOUFLAGE—During the past year, we have been working with the U. S. Engineers in developing the Rejuvo System for camouflage purposes and a number of trial installations have been made. This special material and equipment for its application are available through the Carey Branch Office organization.

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Dependable Products Since 1873
LOCKLAND . . CINCINNATI, OHIO
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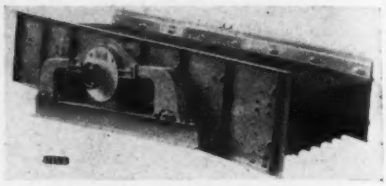
extended shaft of the standard winch often found on a utility truck.—*Gar Wood Industries, Inc., Detroit.*

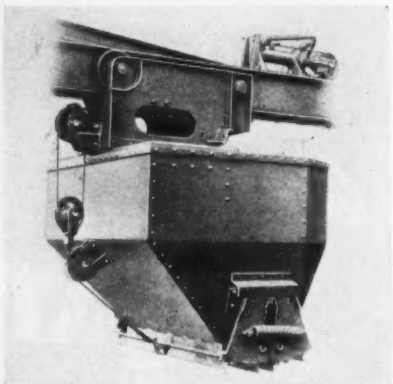
Air Raid Siren

An air raid siren that is audible for miles, has a rising sound pitch or howl that reaches its maximum tone in from 3 to 5 seconds. It is said to be well adapted to signaling because of a sharp sound cut-off. It operates on steam or air at 50 to 250 lb. pressure, at 425 deg. F. total temperature.—*Foster Engineering Co., 109 Monroe St., Newark, N. J.*



Vibrating Screens

The style "M" Robins-Vibrex is a new, high-speed, unbalanced pulley type vibrating screen that will stand up to overloads, and has a number of features designed to save power, lubricant, screen cloth and general maintenance costs. Inclination of screen, amplitude of vibration and operating speed may all be varied to obtain maximum flexibility of application. The screen is adaptable to dozens of different materials.—*Robins Conveying Belt Co., Passaic, N. J.*



Hydraulically Controlled Bucket

Hydraulic control of its 34-E single and dual drum paver boom buckets has been announced by Ransome. This significant advance in paving equipment permits the paver operator to close the concrete bucket doors after they have been opened without returning the bucket to the inner end of the boom. The new design also permits the bucket doors to be opened or closed to any degree at any

• Galvanized ARMCO Ingot Iron is *ready* and *able* to meet your vital priority requirements. It is *ready* because ARMCO-invented continuous mills are rolling 24 hours a day — every day — to give you what you need when you need it. And it is *able* because basically ARMCO Ingot Iron is a highly refined iron made to endure in corrosive industrial service.

In roofing, siding, gutters, downspouts, ductwork and other applications, its remarkable ductility saves forming time and its time-tested durability saves upkeep dollars. It is reassuring to know that galvanized ARMCO Ingot Iron has the longest actual service record of all low-cost iron or steel sheets. Installations made in 1909 are in good condition today.

Galvanized ARMCO Ingot Iron is generally available on "A" priorities in l.c.l. lots from a nearby distributor or in carload lots from the mill. ARMCO distributors and district offices in all principal cities will give you prompt information on prices and delivery dates. Call them, or write us direct. We'll also be glad to send you a *free* corrugated roofing slide rule and leader selector that will speed up your sheet metal calculations. The American Rolling Mill Co., 681 Curtis Street, Middletown, Ohio.

MADE OF ARMCO INGOT IRON

DEFENSE BULLETIN

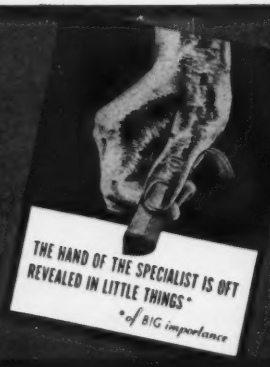
DEFENSE CONSTRUCTION

Must Be Served

A highly important part of the work this plant is doing for National Defense is meeting the demand for all types of hose necessary for construction, repair, and maintenance on Government projects. Such work must go on and is receiving the necessary priority required on rubber and other critical material.

For years Continental hose has been held in high regard in construction fields. In filling such indirect but none the less vital defense orders, all of us at Continental must be constantly alert to give them the same wartime speed and precision which this plant is maintaining on direct orders for Army, Navy and Air Force requirements.

From Factory Bulletin Board of the
CONTINENTAL RUBBER WORKS
MAKERS OF THE VITALIC LINE SINCE 1901
ERIE, PA., U.S.A.



DE LAVAL STEAM TURBINE CO.
TRENTON, N.J.

Manufacturers of
STEAM TURBINES . . . HELICAL and WORM GEARS . . . PUMPS: Centrifugal, Propeller, Clogless, Mixed Flow, Rotary Oil . . . Pump Priming Systems . . . CENTRIFUGAL BLOWERS and COMPRESSORS.

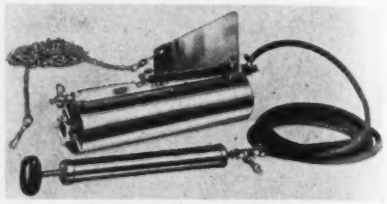
NEED A BIG Trailer?

La Crosse Makes Them Up To 200 Ton Capacity

** WRITE OR WIRE **

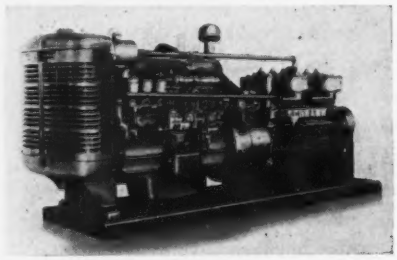
LA CROSSE TRAILER & EQUIPT. CO.
LA CROSSE, WISCONSIN U.S.A.

position on the boom, permitting the entire drum batch to be discharged into the bucket which means a definite time saving. All levers have been eliminated and the boom bucket carriage has no operating parts requiring adjustment or repairs. The bucket doors slide open instead of dropping and provide a clearance from the ground of 23 in. with the doors open and 21 in. when closed. Bulletin No. 195 describes the new bucket.—*Ransome Concrete Machinery Co., Dunellen, N.J.*



Sewage Sludge Sampler

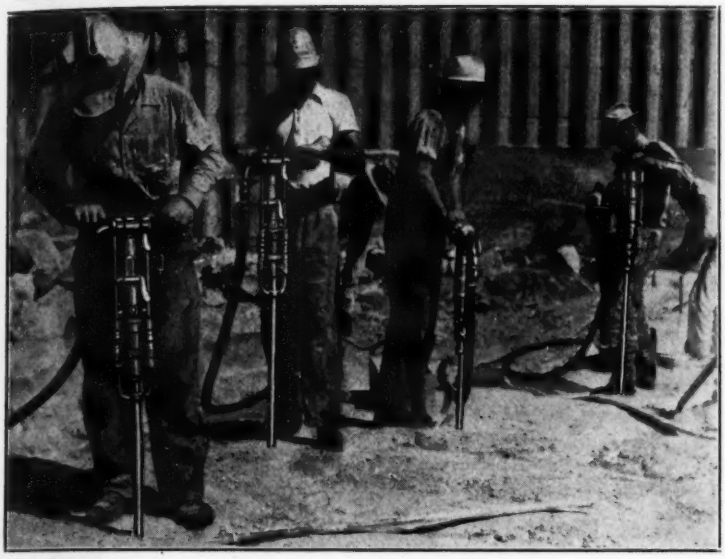
A convenient device known as the P.F.T. Sewage and Sludge Sampler for sampling still or flowing liquids without disturbing liquid bodies or contaminating the samples, consists of a metal cylinder with an inflatable rubber valve at each end supported at the axis of the cylinder. On the one side of the unit is a sample withdrawal cock and a vent cock. The sampler can be used in a vertical position being passed through the well or hand hole of a digester floating cover or septic tank, or it can be used in horizontal position to take a sample from an Imhoff tank or flowing stream. The liquid is allowed to flow through the cylinder for a few minutes, then the valves are inflated, closing both ends of the unit. The sampler is lifted to the surface for removal of material through the draw-off cock. Bulletin No. 133 gives complete details. —*Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago.*



Big Compressor

Another addition to the comprehensive line of Schramm compressors is the new engine drive—in line compressor. Built in sizes ranging from 120 to 600 cu. ft. displacement, these outfits are made available for those applications not reached by electric power service or where gasoline, oil, distillate or diesel power units are preferred as a driving medium. A number of standard assemblies have been pro-

CONSTRUCTION VOLUME ESTIMATE, TEN BILLIONS



↑ **MORE FOOTAGE** per drilling dollar — that's why contractors prefer CP-42 Sinkers. Designed particularly for fast drilling in all formations, excavations, road work, shaft sinking. Low air consumption makes it ideal for use with portable compressors.

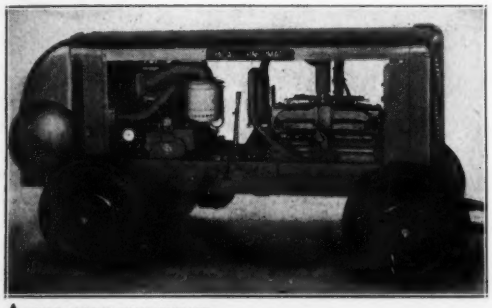
CP CONTRACTORS' DIVISION EXPANDS FOR GREATER SERVICE

Added Personnel, New Products

NEW YORK—Immediately after Pearl Harbor, 1942 construction volume estimates were stepped up to ten billion dollars. Future appropriations may bring the total to record proportions. To aid the industry to meet this huge program, Chicago Pneumatic has further expanded its Contractors' Division. New personnel has been added to the home office and district branches to counsel with contractors in the preparation of bids and selection of time-saving equipment. Improved compressors, advanced models of rock drills, time-saving pneumatic tools, and other specialized equipment are on the Chicago Pneumatic production lines and are rapidly being made available to the construction industry.

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York, N. Y.



↑ **"THE BEST ENGINEERED,** simplest and most efficient portables I have ever seen," a well-known chief engineer said of the CP Portable Compressors. New refinements of design and construction, with the well-known Chicago Pneumatic dependability, economy and low maintenance.

↑ **FOUR-WAY ADJUSTABLE** tilting tower, permitting quick, easy adjustment through 25° either side of vertical; 7½° lateral adjustment to facilitate drilling of angle holes and bring tower to vertical on uneven ground; adjustable rear wheels — just a few advantages of the new G-500 Wagon Drill.

↑ **NOTHING FASTER** than a CP-365 Pneumatic Wrench (impact type) for running nuts off or on. Handles nuts, studs, bolts, etc., up to 1¼" bolt size. Four other models for nuts from ⅜" to 1¾" bolt size. All have powerful rotary motors and gearless spring drives — insuring low maintenance costs.

312,000 CUBIC YARDS → of mass concrete placed on one large dam job with four CP-518 Vibrators, at a cost for repair parts of only 1.7 mills per cubic yard! Low maintenance costs characterize all seven models of CP Pneumatic and Electric Vibrators.

CHICAGO PNEUMATIC

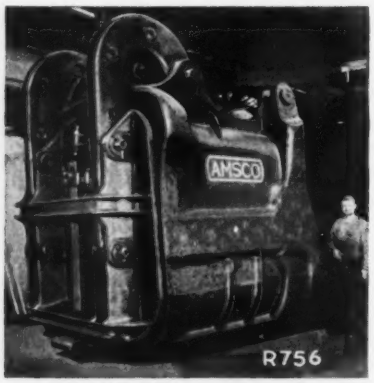
CONTRACTORS' EQUIPMENT

Air Compressors, Rock Drills, Pneumatic Tools, Vibrators, Pumps, Electric Tools, Diesel Engines

Victories *Are Not* Won On The Battlefields Alone

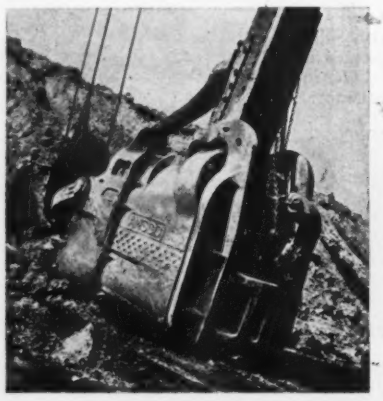
They're won on the production lines, in the mills, the mines, the wheat fields. The defeated Central Powers found this out in World War I.

Amsco Power Shovel Dippers are mustered for Defense in hundreds of mines, quarries and pits, and on construction projects and dredging operations. Digging materials vital to defense production, scooping out excavations for defense plants, gouging out rock and gravel for cement and road materials, dipping up sand and muck for harbors, slips and drydocks.



They're digging in for Defense—an Amsco 16 yd. Dredge Dipper recently shipped for harbor work (R756)—an Amsco 12 yd. Renewable Lip Dipper at an Illinois strip mine—a new Manganese Steel dipper front (R688) to renew an Amsco-Missabe 2½ yd. Dipper used in a road stone quarry. This type of dipper is widely used for the most abusive services.

Made of Amsco Manganese Steel, "the toughest steel known," Amsco Dippers resist abrasion and impact longer than other metals, and their design contributes fast, full loading and clean dumping. With Amsco Renewable Lip Dippers, it is unnecessary to scrap entire front when lip has become worn.



Amsco
AMERICAN MANGANESE STEEL DIVISION
OF THE AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago Heights, Illinois

Manganese Steel Castings for shocks and abrasion.
Chromium-Nickel Alloy Castings for heat and corrosion resistance.
Power Shovel Dippers. Dredge and Industrial Pumps.
Welding Materials for reclamation and hard-surfacing.

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO. OFFICES IN PRINCIPAL CITIES

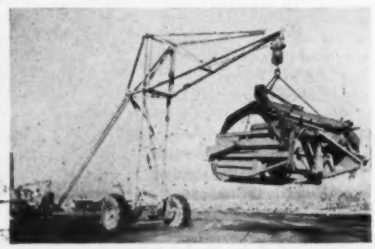
vided in semi-portable and stationary types. It is suitable for installation in isolated or arid locations where running water is not available using Schramm radiator water cooling.—*Schramm, Inc., West Chester, Pa.*

Double Angle Moil Point

A double angle moil point, having exceptional cutting speed and resistance to wear, is now on the market. The shank is hexagon, the taper is square, and the cutting point is round. The points are heat treated for special qualities of the steel and to give the point long resistance to wear. It is available in lengths of 14 to 30 in. with shanks 1⅛ in. and 1¼ in. by 6 in.—*The Iron City Spring Co., 2913 Smallman St., Pittsburgh, Pa.*

Blackout Paint

A new black paint of complete opacity is said to possess remarkable weather-resisting qualities together with the feature of overnight drying. Introduced as Thompson's SP-3000 "Eclipse" blackout paint, it comes ready to use, and is applied quickly and easily by either brush or spray. It has been under development more than a year to make it the dead flat black that totally blocks the passage of light through defense plant windows.—*Thompson & Co., P. O. Box 6757, Pittsburgh, Pa.*



LeTourneau Crane

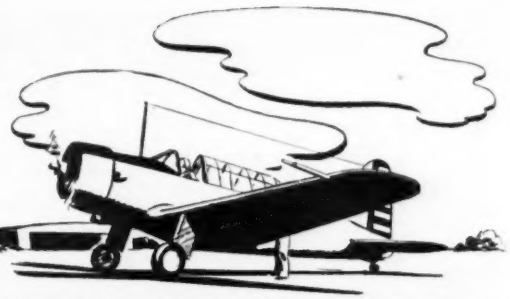
Two cranes, the L20 and L40, have been released for distribution and are designed for handling bulky material. They have lifting capacity of 20,000 lb., at a horizontal distance of 20 ft. 6 in. from axle center in upright position.

EXTREMELY SATISFACTORY

"We are pleased to inform you that our experience with three new "99" Austin-Western power graders during 1941 was extremely satisfactory. These machines were used at Windsor Locks Airport, Connecticut, and at various Forts in Massachusetts. In all cases they handled excellently and were very low in maintenance cost.

"Any future grader purchases will certainly be from Austin-Western." Very truly yours,

John McCourt Co. and John P. Condon Corp.
By F. M. McCourt, President



STEAL A MARCH ON EVERY JOB YOU TACKLE

● Because of its exclusive features the "99-M" simplifies and speeds up all ordinary jobs of war and civilian construction and maintenance. Its powerful all-wheel drive, power-operated steer on all wheels, power blade shift, and effective neutralization of blade side-draft saves time and money on difficult jobs . . . making it possible to profitably handle narrow-margin contracts . . . utilizing budget dollars so they go a lot further and do a lot more work.

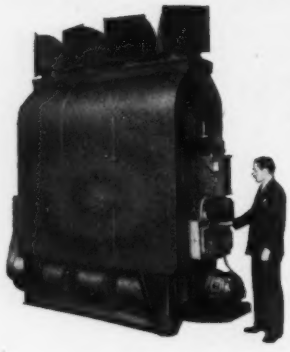
When the "99-M" is given an opportunity to demonstrate how its greater traction and more usable power steps up output . . . enables it to take over jobs formerly requiring several part-time machines . . . repeat orders automatically follow as additional equipment is needed. On one armament project alone, twenty-two fast-working "99-M's" are now teamed up . . . and are setting up a mammoth record of speed and accomplishment.

Investigate the "99-M" now. See for yourself how it helps steal a march on time and costs . . . on every job you tackle. THE AUSTIN-WESTERN ROAD MACHINERY CO., Aurora, Ill.

MOTOR GRADERS • ELEVATING GRADERS • SCRAPERS • CRUSHING AND SCREENING PLANTS
LOADERS • ROLLERS • ROLL-A-PLANES • MOTOR SWEEPERS • SHOVELS AND CRANES

DRAVO DIRECT FIRED HEATERS *the answer*

to your heat problems on quick construction for defense . . .



NEW plants . . . additions to existing structures may be heated at surprisingly low cost during construction and permanently after completion with Dravo Direct Fired Heaters.

These heaters provide inherent advantages of low initial and operating costs and flexibility of installation. Burning gas, oil or coke oven gas, they produce proven heat transfer efficiencies up to 85%. Air is warmed and delivered when and where needed—instantly—economically—showing distinct savings over conventional heating systems.

Stock sizes with 750,000 to 1,500,000 B. t. u. output are available. Group installations can be arranged to heat any large industrial building.

SEE OUR CATALOG IN SWEET'S

We are prepared to quote on the bare units or complete installation. Dravo Bulletin No. 502 contains complete, usable data and will undoubtedly save you weeks of time. Time was never more precious—if your job requires heat quickly and economically for years to come—consult your Sweet's or write us for descriptive literature.

DRAVO CORPORATION

Machinery Division — Heater Department

DRAVO BUILDING · PITTSBURGH, PA.

4800 Prospect Avenue, Cleveland — Broad Street Station Building, Philadelphia

MITCO

OPEN STEEL FLOORING

Pressure Formed — 90% Open Area

Easy to Install

Hendrick Manufacturing Company

45 Dundaff Street, Carbondale, Pa.

"GUNITE"

can reduce your construction costs. It is efficient and dependable, an established product.

WE RECOMMEND "GUNITE" for structural steel protection, floor and roof slabs, thin exterior walls, partitions, tanks, reservoirs, restoring disintegrated concrete surfaces, repairing reinforced concrete, etc. Let us suggest how "Gunite" can best solve your problems.

PRESSURE CONCRETE CO.

"GUNITE" CONTRACTORS

6 Avenue B — Newark, N. J.

They are available in 20 and 40-foot boom lengths and are operated from any size tractor or Tournapull with a Le-Tourneau double-drum power control unit. They offer large crane lifting power with tractor mobility as they are mounted on rubber tires to permit travel over concrete surfaces and yet give ample flotation for working in soft, mucky conditions.—*R. G. LeTourneau, Inc., Peoria, Ill.*

Blackout Black

A new blackout coating for industrial plant windows and skylights has been announced to be known as Carbozite standard "Black-out Black." This coating is not a paint but a smooth flowing liquid coating, manufactured from a pyrobitumen ore, especially refined and mixed with quick drying, volatile solvents and a secret ingredient which provides complete opacity and an absolutely gloss-free surface. No preference rating or priority is required as non-essential materials are used. Material can be sprayed or brushed on quickly and only one coat is required to assure complete protection against light penetration. Black-out Black is readily soluble in gasoline or other light petroleum solvents and consequently may be readily removed when the danger period is past.—*Carbozite Corp., Pittsburgh, Pa.*

Portable Ozone Unit

A portable, automatic unit that produces pure, clear, colorless, tasteless, odorless water without the use of chlorine or other chemicals, is now on the market. The unit, known as the Sterozone Model B, has a capacity in excess of 1200 gal. per hr. and can be installed on any tank or water storage container. For field use a 250-gal. canvas bag is used. Power is supplied from 110-volt, 50–60 cycle outlet or by a portable gasoline-electric generator. Operation is entirely electrical and no chlorine or other chemicals now restricted for military requirements are needed. The sterilizing agent employed is ozone generated by the silent electrical discharge maintained at 11,000 volts. In-

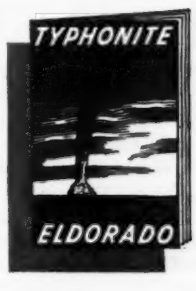
Eldorado's Opaque Line is AN ORIGINAL BLACKOUT

Eldorado's blackouts are always a full success! Each mark, each line is a complete black-eye for that common enemy—MISUNDERSTANDING. When the draughtsman makes his drawing, each inch of it is as he wants it. And it shows up that way on the blueprint! Clear! Distinct! Even! What this means to American production cannot be estimated.

Only Dixon, the makers of Eldorado, are permitted to use the Typhonite process. Through this method, graphite is smashed to minute particles of even size. These make a lead that's smooth, dependable, unerring—the kind you need.

Interesting booklet—*free!*

A little history of pencil-making describes the Typhonite process—it's informative, fascinating. Please write on your professional or business stationery.



PENCIL SALES DEPARTMENT 227-J2 • JOSEPH DIXON CRUCIBLE CO. • JERSEY CITY, N. J.

Look at the Construction Features of this **NEW IMPROVED BUDA ALL-PURPOSE AUTOMATIC LOWERING JACK**

Conveniently located handle.
Five foot link chain with two hooks, broadens use of jack, permitting the lifting of objects from below its base.
Double lever socket permits raising or lowering in most convenient manner.
Reversing lever located where it can be quickly changed by merely pushing against it with hand, foot or lever bar.
Toe lift for low lifting jobs, moving machinery, etc.
Hinged base enables jack to be tilted for pole pulling, straightening, etc.
BUDA

● Buda now offers a new improved Automatic Lowering Jack to handle all-purpose lifting jobs up to 15 ton loads. This sturdy jack, model 2215-S, embodies new design and construction features that mean easier, faster, more dependable lifting.

One of its outstanding advantages is the use of a larger, heavier base to assure complete stability and safety, particularly when the jack is being operated at an angle. Write today for complete details about this newest Buda *Tested* Jack.

Send for the new 32-page illustrated booklet covering the correct solution to all types of lifting problems. Ask for Bulletin 1066.

Builders of Quality Lifting Jacks for 31 Years

THE BUDA COMPANY
ESTABLISHED 1881
Harvey (Chicago Suburb) Illinois
Diesel and Gasoline Engines—Railroad and Contractor's Equipment

Buda Jacks are all tested and guaranteed for long life service. Over 170 styles and sizes—1 to 100 Tons capacity.

COMMERCIAL LINER PLATES *and* SUPPORTS . . . MAKE TUNNELING A *SAFER, FASTER, MORE PROFITABLE* PROJECT

On every tunneling job, the selection of COMMERCIAL Liner Plates and Supports is further assurance of rapid, safe and economical construction. Here is an example of the application of COMMERCIAL Supports . . . the Duchesne Tunnel of the Provo River Project, Kamas, Utah. This small diameter tunnel clearly shows the clean, neat appearance COMMERCIAL Supports bring . . . the greater working area . . . the safer conditions. These characteristics, which are found in every COMMERCIAL-lined tunnel, are worth considering the next time you recommend plates or supports for a tunnel job. COMMERCIAL offers sizes for all tunnels, for every type ground. Write for details today!

THE COMMERCIAL SHEARING & STAMPING CO.
YOUNGSTOWN **OHIO**

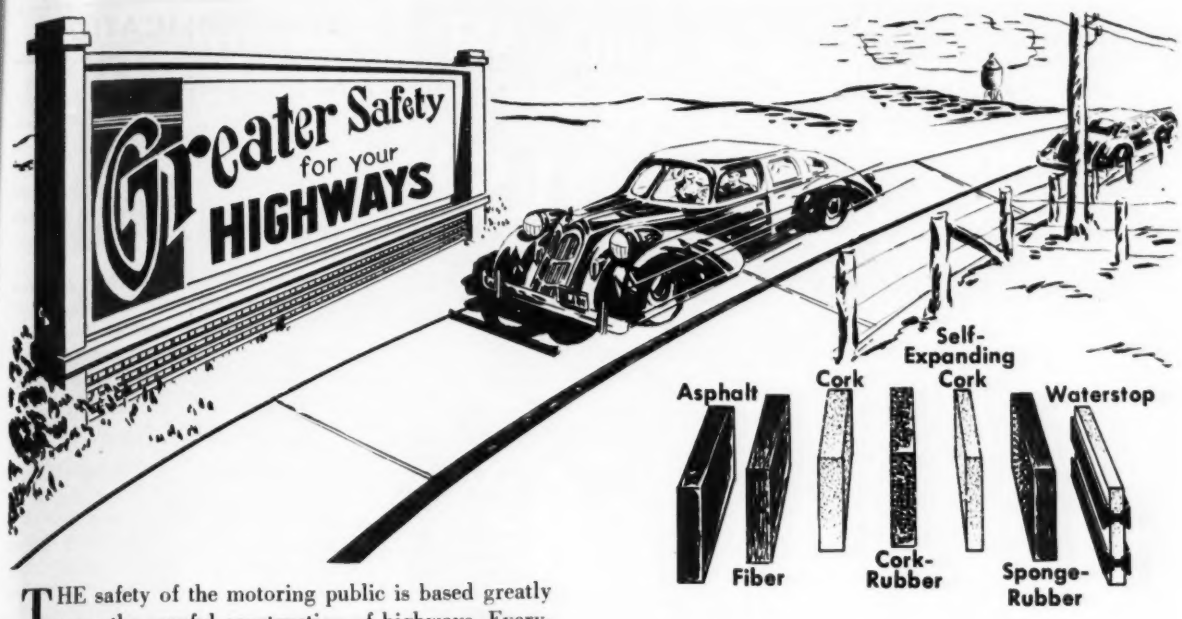
jected directly into the water passing through the unit, the ozone completely oxidized bacterial contamination and produces palatable water.—*Technicraft Engineering Co., 5610 S. Soto St., Los Angeles, Calif.*

Tread Renewal

Goodrich offers to change the tread on all kinds of heavy tires to suit the necessities of equipment which may change from one type job to another as well as renewing the tread when it is worn down. For contractors this is particularly important because changing from job to job, tire service requirements change. Today's job may require extra traction such as is found in the earth-service type; tomorrow's work may be in rock. Goodrich will provide the type of tread best suited to the job at hand. Tread renewal of large off-the-road tires is accomplished at the factory by experts thoroughly experienced in handling big tires. The tires are carefully inspected, minor injuries repaired and a new tread applied of the same high quality used in new tires. Ask for your copy of "Tires Designed for the Construction Industry" which carries information on this service.—*The B. F. Goodrich Co., Akron, Ohio.*

Heavy Duty Unit Heater

A heavy duty unit heater has been added to the Janitrol line of gas-fired space heating equipment. This product is for the heating of large buildings such as airplane hangars, factory buildings, steel mills, arsenals and the like. The unit is built up of a series of sections, each section having an input rating of 250,000 B.t.u. per hour. Each section is complete, having its individual heat exchanger assembly, pilot, limit control and blower. The blowers of all the sections are mounted on a common shaft and driven by one motor. Ask for Bulletin "The BBC-24 Series Janitrol Unit Heater."—*Surface Combustion Corp., Toledo, Ohio.*



THE safety of the motoring public is based greatly upon the careful construction of highways. Everyone enjoys a feeling of security while driving along a well-maintained road. Neglected and cracked highways not only increase maintenance costs but endanger the lives of motorists.

SERVICISED has contributed a great service to the construction industry by developing a product known as PARA-PLASTIC Hot-Poured Rubber Sealing Compound, for maintaining safety and longer lasting highways. This hot pouring composition differs materially from the ordinary type of asphalt. Composed of asphalt and rubber materials, PARA-PLASTIC contains innumerable qualities that have no equal as a joint or any crevice sealer. It is resilient and adheres to the concrete perfectly regardless of concrete slab contraction even during zero degree temperatures.

The severest detriment to concrete construction is the heavy rainfalls we receive in the Spring. Open joints and crevices in concrete have occurred again as the result of Winter's freezing temperatures causing contraction of concrete—and cracking of previous ordinary sealing. Maintenance cost of these problems usually runs high.

PARA-PLASTIC Hot-Poured Rubber Sealing Compound insures a positive joint seal under any climatic conditions. This product is nationally known and is recognized by the various State Departments.

Investigate further about the mighty "gripping" merits of this fine product.

SERVICISED PRODUCTS CORP.

6051 West 65th Street Chicago, Illinois

EXPANSION JOINTS

Another great achievement developed by SERVICISED in the interest of construction work are the various expansion joints illustrated above. SERVICISED is the only manufacturer of all of these different types of premoulded expansion joints. These products also have gained national recognition in construction jobs such as highways and concrete roads, monolithic structures, dams, bridges, flood walls, etc. The Waterstop Expansion Joint is rapidly being known as "the water-tight seal."

Right now, our many products are servicing National Defense Projects on a large scale!

Send For Your FREE COPY Of The Latest Facts On Expansion Joints and Water Seals.

SERVICISED has just completed a new catalog with combined facts on Expansion Joints and Water Seals. Complete descriptions and interesting functions of our products are well illustrated. The size of the catalog is 8½"x11" and contains 16 pages—ideal for AIA standard file. We urge you to send for your copy now.

PLANTS THAT MUST BE BUILT FAST CAN BE BUILT FASTER with SKILSAW TOOLS!

NEW plants, enlarged plants, remodeled plants—they're needed *FAST* for America's victory . . . they're finished *FASTER* when SKILSAW TOOLS are on the job, speeding up building each hour of each day. *Are skilled hands scarcer?* One hand with SKILSAW does the work of ten! *Is time too short?* SKILSAWS cut days from schedules . . . SKILSAW DRILLS punch holes in bottlenecks! *Do you want proof?* 9 out of 10 defense contractors use SKILSAW TOOLS! Ask your distributor for a demonstration.

SKILSAW, INC.
4771 Winnemac Ave., Chicago
New York · Boston · Buffalo · Philadelphia · Detroit
Cleveland · Indianapolis · St. Louis · Kansas City
Atlanta · New Orleans · Dallas · Los Angeles
Oakland · Seattle
Toronto, Canada

SKILSAW trims roof sheathing faster . . . after it is nailed to save extra time.

SKILSAW quickly cuts plywood panels . . . speeds up concrete form work . . . makes pocket cuts swiftly.

SKILSAW DRILL speeds up timber boring. Powerful, compact for close-quarter drilling.

SKILSAWS speed up *all* sawing! Trim off roof sheathing and decking after it is laid . . . cut flat and corrugated metal and asbestos cement roofing. Speed up remodeling and expansion . . . cut out old flooring, make pocket cuts. Size and trim all lumber. 9 Powerful Models.

SKILSAW DRILLS speed up all drilling . . . from lightest drilling of lead holes for hardware and fixtures to heaviest boring in timbers for bolts and lag screws in heavy construction. Swiftly drill holes for all electrical conduit, plumbing and steam pipes. 22 Powerful Models.

SKILSAW PORTABLE ELECTRIC TOOLS
★ FOR THE DEFENSE OF AMERICA ★

"IN THESE DAYS - - -

of America's supreme effort of self-defense, we pause to renew our pledge of leadership in the design, use of quality material and precision craftsmanship—for all industries, using *Dandux Canvas Products.*"

C. R. DANIELS, INC.
101 Crosby St. **New York, N. Y.**

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NEW PUBLICATIONS

New Publications listed will generally be sent gratis to those requesting them on stationery of companies engaged in the work they refer to. Requests of others, or for more than one copy, should be briefly explained. Address requests directly to the manufacturer.—Editor.

Snow Plows—A new booklet on snow removal, 8 pages in two colors, is available describing the various models of LaPlant-Choate snow plows manufactured for use with Caterpillar diesel tractors.—*LaPlant-Choate Mfg. Co., Inc., Cedar Rapids, Iowa*

Wood Highway Structures—Timber highway structures are illustrated in detail and much informative data are given on guard rails, wood stave culverts, timber underpasses for cattle, cribbing, composite (timber and concrete) decks and numerous types of highway bridges in a booklet "Highway Structures of Douglas Fir".—*The West Coast Lumbermen's Association, Stuart Building, Seattle, Wash.*

Hollow Precast Slabs—A booklet describes Bison floors made of hollow reinforced concrete generally precast but also practical for casting in place. Casting is done with an air filled rubber bag in a canvas cover to form a core which is withdrawn and reused. Units are hauled to the site, erected and then grouted into a solid slab.—*Concrete Limited, Stourton, Leeds, England.*

Glass Blocks—Several pamphlets have been issued by the Owens-Illinois Glass Co. to show methods of installation of glass blocks to replace steel sash and wood sash windows in buildings.—*Insulux Products Division, Owens-Illinois Glass Co., Toledo, Ohio.*

Power Distribution—Now available is a new 16-page, two-color booklet explaining the basic principles of load-center power distribution for industrials, naval and military projects, shipyards, central stations, and commercial buildings. This bulletin lists the chief advantages of the system; illustrates the available circuit arrangements; describes the necessary equipment for such a system as manufactured by General Electric; and depicts typical installations of load-center unit substations—all in highly interesting, easily understandable form. —*General Electric Co., Schenectady.*

Air Brushes—A new catalogue covering the complete line of spray equipment, both manually and automatically operated, in addition to Pneumix air motored agitators for all mixing jobs in batches up to 200 gallons. The intro-

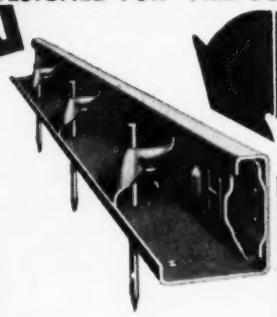
SPEED UP DEFENSE CONSTRUCTION

and PREPARE FOR POST-WAR CONSTRUCTION

Specify HELTZEL

CONCRETE BATCHING AND FORMING EQUIPMENT

DESIGNED FOR "ALL OUT" PRODUCTION *and* DURABILITY



Military Highway Forms (¼" Steel) for Modern Highway and Airport Runway Construction. Cat. B-19.

General Duty Concrete Buckets from ½ to 3 cu. yd. capacity . . . Adjustable gate opening . . . Neoprene Seal . . . Center line discharge . . . Grout tight. Catalog T-29

PORTABLE BATCHING BINS FROM 35 TO 100 TONS CAPACITY . . .

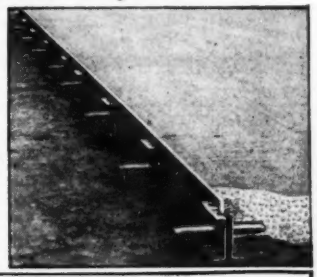
Truck Mixer Batch Truck or Separate Compartment Batchers Suspended on Dial or Beam Scales

HEL-CO *Modern Armor-Dowels*

The NEW method of doweling for BOTH Longitudinal and Transverse Expansion & Contraction Joints in CONCRETE SLAB CONSTRUCTION . . . is already in use in State Highways and in Army airport paving and building floors.

SHEAR PLATE DESIGN GIVES 34% MORE SUPPORT THAN OLD METHOD *(See Drawing)*

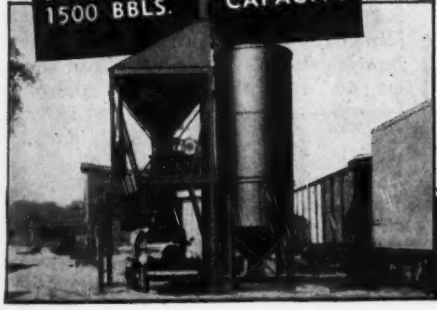
RIGHT: HEL-CO ARMOR-DOWELS in TYPICAL TRANSVERSE JOINT . . .

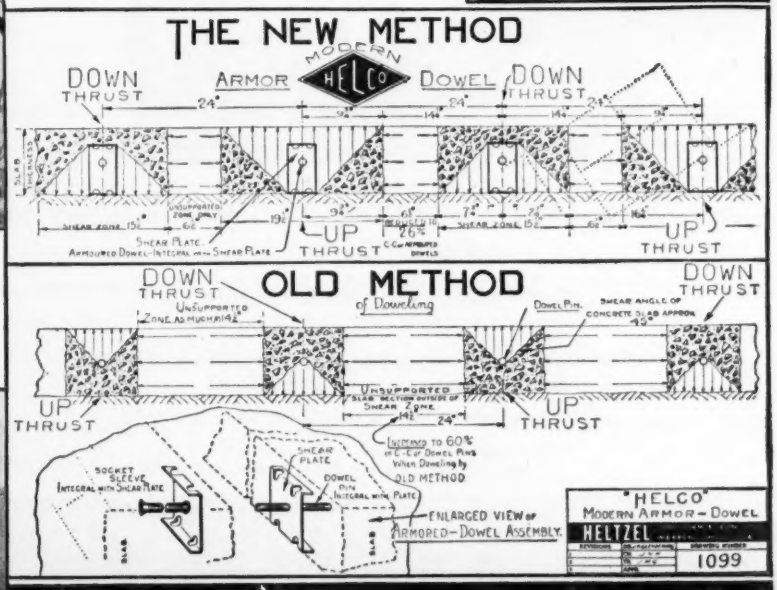


LICENSED UNDER HELTZEL-WILLARD PATENTS

BOLTED BINS FROM 100 TO 400 TONS FOR AGGREGATES ONLY OR For Batching Aggregates & Cement in Combination

PORTABLE BULK CEMENT PLANTS FROM 100 TO 745 BBLS. CAPACITY with BUILT IN ELEVATOR . . . STATIONARY PLANTS to 1500 BBLS. CAPACITY

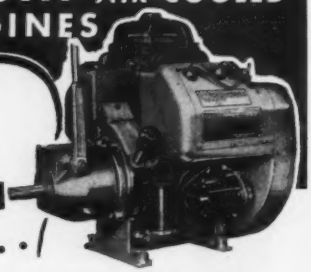




HELTZEL STEEL FORM & IRON CO. WARREN, OHIO · U. S. A.

WISCONSIN HEAVY-DUTY AIR-COOLED ENGINES

In Step with TODAY'S INCREASED PRODUCTION DEMANDS . . .



Wisconsin Heavy-Duty Air-Cooled Engines are supplied in a full range of sizes from 1 to 35 hp., in 1 and 4 cylinder types. Illustrated is the sensational **Model VE-4** 4 cylinder V-type engine. Delivers 22 hp. at 2600 R. P. M. Weight: 285 lbs.

In war service and in essential industries, both men and machines have to deliver MORE today than ever before. The ability to OUTDO and OUTLAST the job that is to be done; the inbuilt capacity to keep on "taking it", no matter how tough the going . . . is a prime requisite to winning this war.

It is because Wisconsin heavy-duty AIR-COOLED Engines (1 to 35 hp.) have this characteristic to a marked degree . . . that they can help YOU keep step with the insistent and necessary demands for *increased productive capacity*. You can *depend* on Wisconsin Engines . . . supplied as standard power equipment by more than 300 machine manufacturers . . . in *your* industry as well as in many others.

MOST POWER Per POUND

WISCONSIN MOTOR Corporation

MILWAUKEE, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

DREDGING

Filling, Land Reclamation, Canals and Port Works

River and Harbor Improvements
Deep Waterways and Ship Channels

We are equipped to execute all kinds of dredging, reclamation and port work anywhere in the United States

Contractors to the Federal Government

Correspondence invited from Corporate and Private Interests Everywhere

Largest Plant — Longest Experience

Atlantic, Gulf and Pacific Co.

New York
21 Park Row

Houston, Texas
Scanlon Bldg.

ductory section outlines reasons for the low pressure principle under which all Eclipse spray equipment operates.—*Eclipse Air Brush Co., Inc., Newark, N. J.*

Arc Welding—"Modern Arc Welding Technique" is the title of a catalog describing the Lincoln "Shield-Arc," the welder with self-indicating dual continuous control. The bulletin features the dual continuous control and describes the many pieces of Lincoln equipment available for use.—*Lincoln Electric Co., Cleveland, Ohio.*

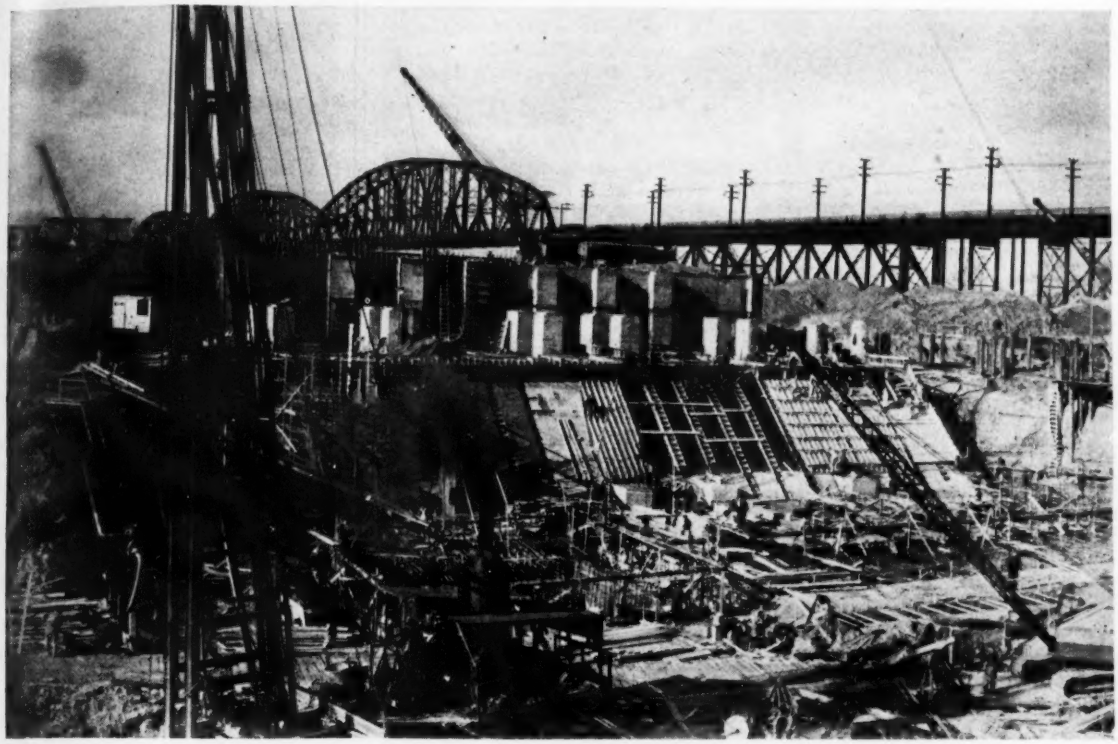
Safety Products—Something different in catalogs for filing is presented by Kimball in the file folder entitled "Kimball Safety" which contains subheaded folders on eye protection, body protection, hand protection and welders' supplies. Each of the several folders is well illustrated and the entire folder is designed to fit readily into your file so that you can easily find safety equipment and, incidentally of course, the name of Kimball.—*Kimball Safety Products Co., 7314 Wade Park Ave., Cleveland, Ohio.*

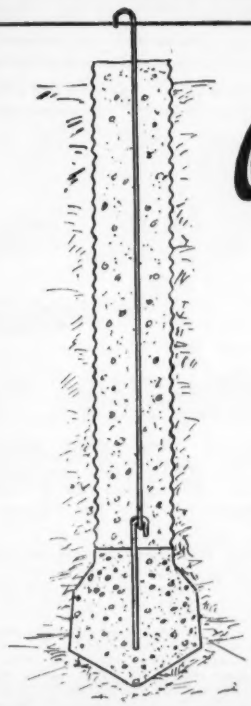
Tire Conservation — An Operator's Handbook just published by Goodrich gives new data on obtaining maximum service from truck tires. Included in a 15 page section dealing with "Factors governing truck tire service" are charts and tables portraying the value of proper inflation and loads, the danger in over- and under-inflation, mismatching of dual tires, causes of uneven tread wear, and the effect of overloads and excessive speeds in generating heat. These and other factors are summarized in 20 practical rules showing truck operators how to obtain maximum service life from their truck tires.—*B. F. Goodrich Co., Akron, Ohio.*

Water Softeners—A new bulletin describes Graver Zeolite water softeners giving full information on equipment and chemicals needed for different waters.—*Graver Tank & Mfg. Co., Inc., East Chicago, Ind.*

Timber—"Behind the Eagle Stands the Forest" is a book which undertakes to show pictorially the part the forest products industries are playing in America's preparations for the war. Unusual structures are illustrated pictorially with special attention given to defense housing and use of the material in shipbuilding yards.—*Timber Engineering Co., Inc., 1337 Connecticut Ave., N. W., Washington, D. C.*

Shop Trucks—Buda has announced a new ½ ton industrial shop truck known as the "Buda Chore Boy." This new truck weighs only 800 lb., is fast with





Old Man River

versus

BUTTON BOTTOM PILES . . .

AT VENICE, ILLINOIS, the Mississippi's 52-foot head of water delivers 3200 pounds per square foot of hydrostatic uplift on the underside of the floor of the Union Power Company's main Power House.

Part of this pressure is resisted by the building load, the balance by Western's Button Bottom Piles, designed to take tension by internal reinforcement connecting with a hook cast into the buttons.

IN CHICAGO, Western developed another type of tension pile to resist wind pressure on two of the Bartlett Hayward Company's mammoth waterless gas holders — of 15,000,000 and 20,000,000 cubic feet capacity respectively.

UPLIFT MAY BE ONE OF YOUR FOUNDATION PROBLEMS. In a hangar — lift bridge — smokestack — craneway — radio, transmission or parachute tower. If so, why not let Western take a crack at devising a safe, economical solution?

WESTERN FOUNDATION COMPANY
WESTERN CONCRETE PILE CORPORATION

New York Office
52 Vanderbilt Ave.

Chicago Office
308 W. Washington St.

To prevent scouring and undermining ARMCO sheeting was driven into the streambed 30 inches from the abutment face. J-bolts anchored the sheeting and a firm footing was provided by cleaning and filling the open space with concrete.

A Saving Hint ON BRIDGE MAINTENANCE

• When scouring or undermining weakens bridge abutments here is a helpful hint: Use ARMCO Sheeting to assure a firm footing, reduce maintenance and protect the bridge structure.

Then you will have the same advantages that make ARMCO Sheeting ideal for trench work, cofferdams, cut-off walls and bulkheads. The corrugated metal design provides ample strength without excessive weight, which means quick, easy handling. It drives fast because of the small displacement area and smooth surfaces. On temporary jobs you can pull ARMCO Sheeting again and again for re-use. Individual units nest snugly together for space-saving in storage or transit.

An ARMCO Sheeting is supplied for every purpose—Flange Type, Clip-Type and Interlocking. Write for data. Armco Drainage Products Assn., 125 Curtis Street, Middletown, Ohio.

ARMCO SHEETING

quick acceleration; it has foot throttle speed control and handles easily at all speeds. It is driven by a 4-cycle air cooled 7.7 hp. engine which averages about 35 miles per gallon. Load capacity is 1000 lb. on a loading space of 12.8 sq.ft. Its width is only 37 in. and the three wheel construction permits turning in a 7 ft. 3 in. radius.—*The Buda Co., Harvey, Ill.*

Canteen—"Why Feed Your Employees" contains information useful to production men and executives vitally interested in saving time and increasing the efficiency of plant operations by supplying food for their employees.—*Mono Service Co., Newark, N. J.*

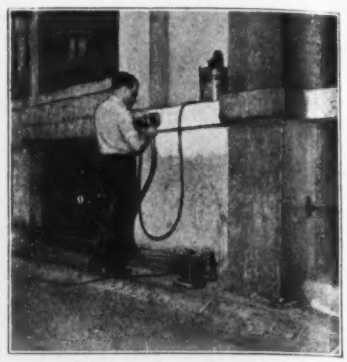
Big Paver—A new catalog, well illustrated in color, presents a description of the mixing action of the Koehring 34-E Unibatch paver. All features and dimensions of the paver are fully described, including the twin-door boom bucket.—*Koehring Co., Milwaukee, Wis.*

Crawler and Wheel Mounted Cranes—A new catalog, No. 4132, features Osgood Type 70 air control shovels, cranes, draglines and clamshells on crawler treads suitable for the heaviest construction work. Another catalog, No. 4128, describes the new Osgood Mobilcrane available in three sizes. This is a one-man controlled, one engine operated machine with independent motions of hoist, swing, travel and boom.—*The Osgood Co., Marion, Ohio.*

Sewage and Sludge Pumps—Bulletin No. 206-2 describes a type of pump primarily designed for handling of unscreened sewage but useful for handling of sludge in industrial and chemical plants where it is necessary to pump liquids containing various solid and fibrous material in suspension.—*Lawrence Machine & Pump Corp., Lawrence, Mass.*

Hydraulic Vise—A new folder describes the hydraulic Visepress controlled by foot pedal which permits the use of both hands in setting up and removing the work. From 1 lb. to 10,000 lb. pressure can be developed between the jaws so it is just as suitable for press operations as on small parts where speed and accuracy are required.—*Studebaker Machine Co., 9 So. Clinton St., Chicago.*

Fluorescent Lamps and Luminaires—The subject of RF (rectified fluorescent) lamps and luminaires is fully covered in a new 24-page booklet which shows how seeing can be made much easier for those who work under this kind of lighting, how factories may have high light output from a lighting system, high efficiency, cool illumination and no dark



MASTER VIBRATOR HIGH-SPEED TOOLS AND CONCRETE SURFACING ATTACHMENTS:

For Wet and Dry Grinding of concrete, Brush cleaning Forms, cleaning steel, pumping water, sanding and polishing. Many jobs other than vibrating can be done with Master Vibrators. It is only necessary to remove the vibrating head by unscrewing same from the casing and screwing on any Master High Speed Tool Attachment.

MANUFACTURERS OF

- Gas-Electric Generator Plants, 500 watts to 240 KVA—AC or DC.
- "Big-3" Gas-Electric Power Units for Electric Generation, Concrete Vibration & Tool Operation.
- Concrete Vibrators—Gas or Electric.
- Concrete Surfacing Attachments.
- Master Power Blow Hammers & Tools.
- Complete line of High Speed Tools.

Master Distributors throughout United States and Canada. All Foreign territories—Armco International Corporation.

Send for # 505 Equipment Manual Today.

Master Vibrator Co., Dayton, Ohio

Compact! Powerful! Safe!

DISTRIBUTABLE CONTROLLED POWER

with **Beebe Bros.** ALL STEEL HAND HOIST — SEATTLE, U.S.A.

★

Money Has Been Saved on These Jobs!

1200' assembled pipe (132 Tons) were lowered to bed of Mississippi at St. Paul with 9—5-Ton Beebes, three lines to each hoist through blocks.

Hudson River Bridge sidewalks were laid in sections with 32—5-Ton Beebes.

Longest wooden trusses in world were installed with ONE 5-Ton Beebe after power hoists proved impractical.

★

When raising, lowering, or placing costs by power are a serious problem, the answer is the right number of Beebe Bros. All Steel Hand Hoists MANNED IN UNISON. Available in 2, 5 and 15 Ton sizes. Sold through leading dealers in all trade centers. List of dealers sent upon request.

BEEBE BROS., 2720 6th Ave. S., Seattle, U.S.A.

★

"THE STRONGEST GEARED POWER FOR ITS WEIGHT IN THE WORLD"

shadows. Ask for Booklet No. Y-1251.—*General Electric Lamp Dept., Nela Park, Cleveland, Ohio.*

International in Defense—"The Strong Shall Be Free!" is the title of a 32-page booklet which describes the work on defense being done by the International Harvester Co. It features truck and tractor equipment for movement of guns and supplies and the ordnance work being handled by the company.—*International Harvester Co., 180 No. Michigan Ave., Chicago.*

Load Lugger—New literature describes the Brooks load lugger, its cycle of operation, and representative uses in construction and quarrying operations. Several buckets can be carried to the point of work at one time, and when being moved the filled buckets are carried well up on the truck to secure correct load distribution. Ask for Catalog No. 44.—*Brooks Equipment & Mfg. Co., Knoxville, Tenn.*

Clay Pipe—A pamphlet featuring the use of vitrified clay pipe in home construction in defense areas features permanency.—*Clay Sewer Pipe Association, Inc., Oliver Building, Pittsburgh, Pa.*

Air Conditioning—A complete line of self-contained air conditioning units providing a size and capacity to meet the requirements of many types of industrial and commercial establishments is described in a new series of bulletins.—*Carrier Corp., Syracuse, N. Y.*

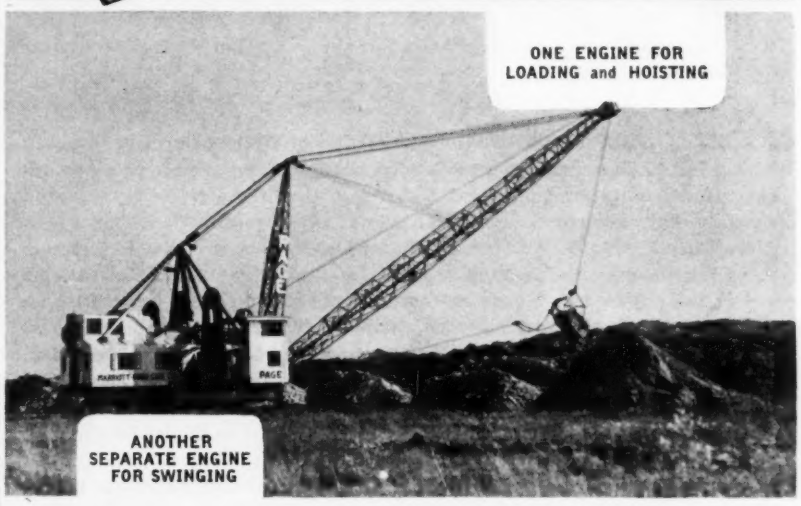
Variable Speed Transmission—A 52-page catalog handbook, which has taken two years to complete, includes 52 pages of recommendations, application data, photos and engineering information. It gives a quick index source of reference for the complete data on Ideal variable speed pulleys, variable speed transmissions, automatic control motor bases, etc.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

Glass Block—A new Pittsburgh-Corning glass block which combines transparency with the insulation value of the usual glass block is described in a new folder.—*Pittsburgh Corning Corp., Grant Building, Pittsburgh, Pa.*

Drainage—A booklet "The Young and Greenawalt System of Right-of-Way Drainage with Corrugated Metal Culverts," tells the story of this well known firm of engineers and their work. Case studies of various jobs with interesting illustrations are included with a description of procedure and practice.—*Young & Greenawalt, Box 90, East Chicago, Indiana.*

Fast

PAGE TWO-ENGINE DIESEL-POWERED WALKING DRAGLINE



SETS NEW YARDAGE RECORDS FOR LARGE DRAGLINES

Visualize using ALL the power of your present dragline for *hoisting.* ONLY . . . without swinging the machine. Hoisting speed would be greatly increased. Now consider a second, independent engine for *swinging,* ONLY. Swing is speeded up in proportion to the faster hoist—the result: MORE YARDAGE HANDLED PER SHIFT.

The Page TWO-ENGINE Walker gives you FAST HOIST and FAST SWING—*at the same time.* It is a miracle of balanced power, speed and flexibility. Even with its TWO Page Horizontal Diesel Engines—it is amazingly compact and economical to operate. Get the facts about a Page TWO-ENGINE Dragline for YOUR job. Mail the coupon below —TODAY!

PAGE Two Engine DRAGLINES

PAGE ENGINEERING CO.
Clearing Post Office Chicago, Ill.

Address this coupon to: Dept. M-43,
PAGE ENGINEERING CO., CHICAGO, ILL.
Mail a copy of your new folder "Page Walking Draglines On the Job" with NO obligation to me.

Name .....
Street .....
City .....

HERE'S THE NEWEST CONTRIBUTION of W&T engineering to public health defense . . . a trailer-type mobile chlorinating unit, designed to provide positive protection of water supplies under emergency conditions, or to meet any need for closely controlled chlorination "on location" without delay.

Using the dependable W&T vacuum principle, the unit provides for solution feed of chlorine over a wide range of application rates up to 300 lb. of chlorine per day. Self-powered by a gasoline motor, it will draw injector water from an open source or pipe line, and apply the chlorine in the main against pressures as high as 100 lb. per sq. in. Two 150 lb. chlorine cylinders are cradled in the trailer, connected to assure continuity of supply. Hoses, cocks, tools and other accessories for making emergency main connections are provided.

Data and experience gained by W&T technical experts in England during the past year, backed by W&T's continuous experience with emergency chlorination equipment extending from before the last World War, are reflected in the design and construction of the unit.

Both trailer frame and chlorinator are designed to stand up under the strenuous conditions of transport and service which exist during emergencies when faithful performance is most essential. Construction is exceptionally rugged to provide ample strength for rigorous duty. SA 120A

The Only Safe Water is a Sterilized Water

WALLACE & TIERNAN CO., Inc.

MANUFACTURERS OF CHLORINE AND AMMONIA CONTROL APPARATUS • NEWARK N. J. • REPRESENTED IN PRINCIPAL CITIES

We can help solve your problems on

SLUDGE • GUM
VARNISH • RUST
and CORROSION

in all types of engines and fuel tanks

SEND FOR ENGINEERING AND SERVICE DATA

PETROLEUM SOLVENTS CORPORATION

331 MADISON AVENUE, NEW YORK, N. Y.

Manufacturers of additives for motor oils and solvents for all types of petroleum residues

Manufacturers' Activities

THE RANNEY WATER COLLECTOR CORP. of New York has transferred its main offices from New York City to the Heyburn Building, Louisville, Ky. The company name has been changed to THE RANNEY CORP.

A. W. HERRINGTON, head of the MARMON-HERRINGTON Co., Indianapolis, Ind., automotive equipment manufacturers, was recently elected president of the Society of Automotive Engineers.

R. H. STURGEON, manager of the small excavator division for the HARNISCHFEGER CORP. of Milwaukee, has been appointed acting head of the large excavator sales division.

F. D. CARROLL has been appointed district sales manager in charge of the Dallas territory for the YOUNGSTOWN SHEET & TUBE Co. His headquarters will be at 610 Continental Building, Dallas, Texas. THE GRIFFIN EQUIPMENT & SUPPLY CORP. of New York has transferred its headquarters to 881 East 141st St., New York. In line with a plan of increased sales and service facilities for the entire West Coast, the PITTSBURGH EQUITABLE METER Co. and MERCO NORDSTROM VALVE Co. have opened new sales offices in San Francisco and Seattle. RUSS WATERS has been appointed branch manager of the new San Francisco office, located in the Hobart Building, 582 Market St., and will have supervision of the new Seattle office as well. The Seattle office, located at 119 W. Denny Way, will be supervised by FRANK P. TANGNEY.

H. E. MERRILL, formerly advertising manager of the GENERAL ELECTRIC construction materials division, at Bridgeport, Conn., has been appointed product promotion manager to supervise sales development of fluorescent devices for both the accessory equipment and the wiring devices sales sections.

W. C. BYRD, formerly sales representative for the RUBEROID Co. in western North Carolina with headquarters at Charlotte, has been appointed sales manager of the company's Baltimore division, to succeed the late Hugh C. Foster. Mr. Byrd's new territory will include Maryland, Delaware, North Carolina, South Carolina, and parts of Georgia, Tennessee and West Virginia.

THE FICHTER STEEL CORP. of New York has announced the establishment of new offices at the Lincoln Building, 60 E. 42nd St., New York, N. Y.

J. H. WATTERS has become president of UNION ASBESTOS & RUBBER Co., succeeding L. L. COHEN, who has been elected chairman of the board of directors. Mr. Watters was formerly general manager of the MARION STEAM SHOVEL Co., Marion, Ohio.

CARL C. BROWN, who was until 1940 sales manager, for the GULF STATES STEEL Co., Birmingham, Ala., died recently.

THE HIGHWAY EQUIPMENT Co., of 4107 Sennett St., Pittsburgh, Pa., has been appointed as distributor for all products of the DIAMOND IRON WORKS, INC., and the MAHR MFG. CO. DIVISION.

DWIGHT A. BESSMER, of Canton, Ohio, has been appointed assistant director of purchases for the TIMKEN ROLLER BEARING Co., Canton, Ohio.

WILLIAM G. CROOK has been appointed manager of sales of the new district office of the CARNEGIE-ILLINOIS STEEL CORP. at Buffalo, N. Y.

F. P. MCKEGNEY, formerly assistant chief engineer of the AIR REDUCTION Co., 60 East 42nd St., New York City, has been appointed chief engineer of the company.

S. FAHS SMITH, 77, president of the S. MORGAN SMITH Co., of York, Pa., died recently.

JOHN E. RUSSELL, formerly manager of the Painesville, Ohio, sales offices of the DIAMOND ALKALI Co., has become a representative of the nation's alkali industries in the OPM. He is succeeded at Painesville by BYRON H. HUFFMAN, formerly manager of the company's St. Louis office.

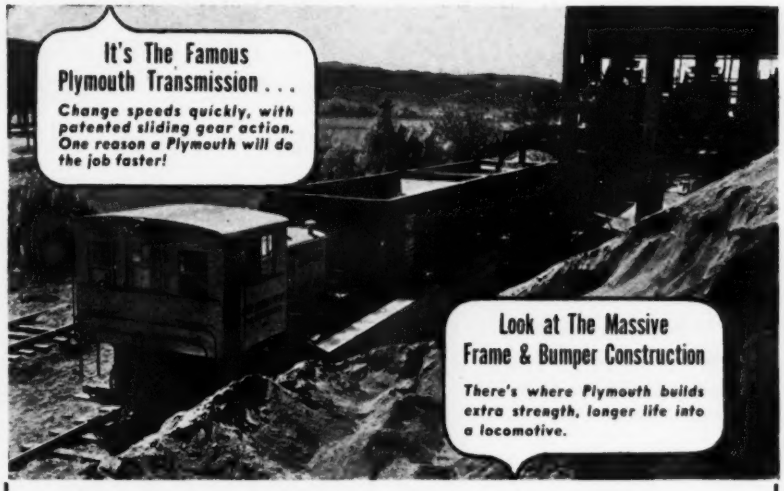
C. M. DANIEL, recently sales promotion manager for the INTERNATIONAL HARVESTER Co. at Terre Haute, Ind., has joined the staff of the sales department of the LAPLANT-CHOATE MFG. Co., INC., at Cedar Rapids, Iowa.

SAUERMAN BROS., INC., Chicago, Ill., have moved their general offices from 438 So. Clinton St. to 522 So. Clinton St. The new quarters will occupy an entire floor.

JAMES B. HAYDEN has been elected vice president in charge of sales for the INDUSTRIAL BROWNHOIST .CORP., Bay City, Mich.

THE CARNEGIE-ILLINOIS STEEL CORP. has announced the appointment of WILLIAM P. ANDREWS as Cleveland district manager of sales, succeeding F. R. GAMMON who was recently named sales manager of the New York office.

J. NELSON HICKS has been appointed manager of the Boston branch of JOHN A. ROEBLING'S SONS Co., Trenton, N. J.


It's The Famous Plymouth Transmission . . .
Change speeds quickly, with patented sliding gear action. One reason a Plymouth will do the job faster!
Look at The Massive Frame & Bumper Construction
There's where Plymouth builds extra strength, longer life into a locomotive.

. . . . . **TALK** over your Locomotive Problems with **PLYMOUTH!**

● When the *right* locomotive goes to work on your job, you start saving time, fuel, money. Get a free analysis of your locomotive problem—from Plymouth's industrial locomotive engineers. Write, wire or phone. . . .

PLYMOUTH LOCOMOTIVE WORKS

—Division of The Fate-Root-Heath Co., Plymouth, Ohio—

GASOLINE • DIESEL • ELECTRIC • BUTANE • PROPANE

Plymouth Industrial Locomotives

BAILEY METERS AND CONTROLLERS

FOR SEWAGE TREATMENT AND WATER SUPPLY . . .

● Venturi Tubes, Weirs, Flumes, Nozzles and other primary elements; Mechanically and Electrically operated Registers and Complete Automatic Control Systems.

BAILEY METER COMPANY

1029 IVANHOE ROAD • CLEVELAND, O.

Bailey Meter Co. Ltd., Montreal, Canada

"FLEX-PLANE"

FINISHING MACHINES AND JOINT INSTALLING MACHINES

FLEXIBLE ROAD JOINT MACHINE CO.

WARREN, OHIO

SIMPLE • RUGGED DEPENDABLE

Better Results with STERLING

405-413 SOUTHWEST BOULEVARD — KANSAS CITY, MISSOURI

STERLING QUALITY

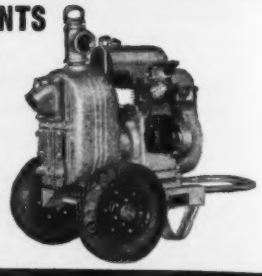
STERLING MACHINERY CORP.

HOISTS PUMPS LIGHT PLANTS

There's a reason why the largest contractors select Sterling Hoists, Pumps and Lighting Plants for their most important jobs. Contractors everywhere have found they can do more work at less cost with Sterling Construction Equipment because Sterling's Fully Developed, Thoroughly Tried and Proven Design assures dependable performance.

Sterling Construction Equipment on your job means increased production and larger profits.

Write for literature and prices.



DOBBIE

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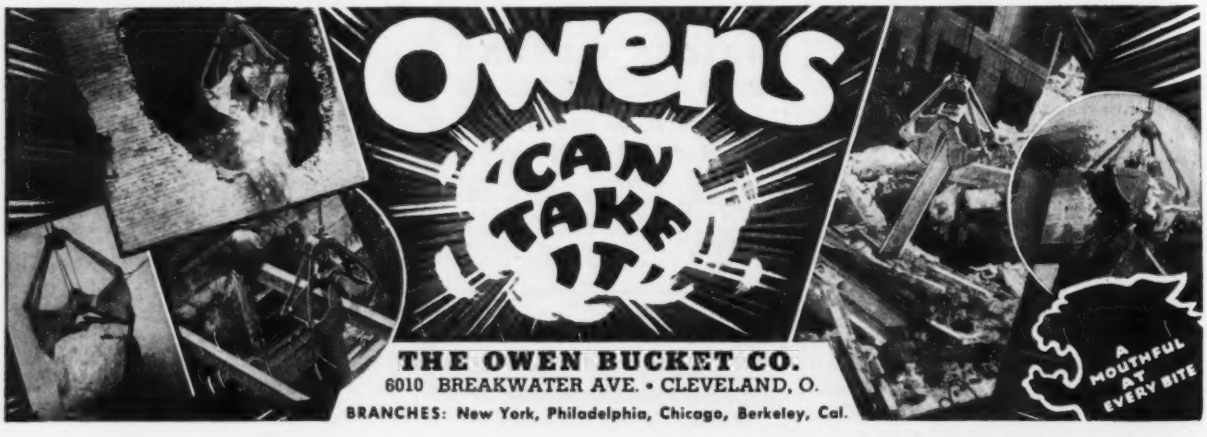

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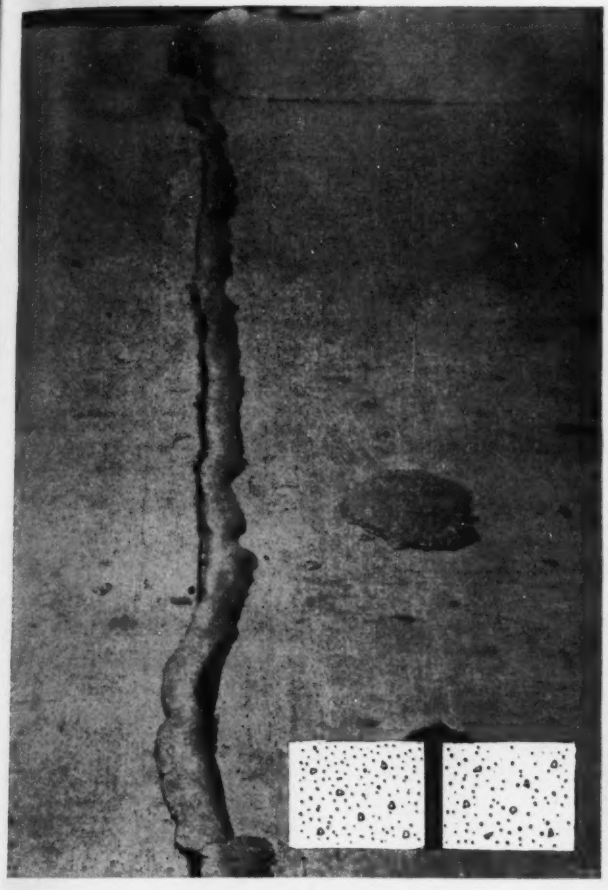

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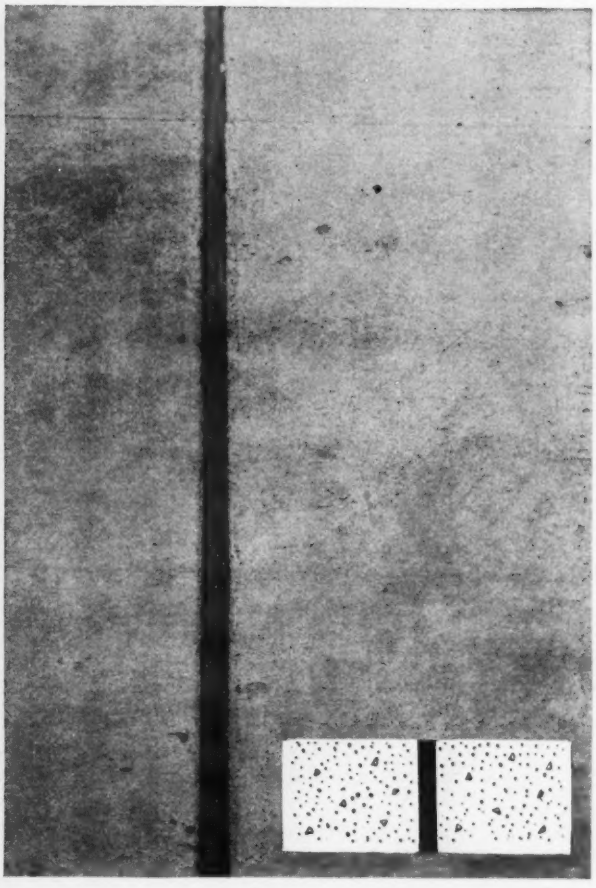

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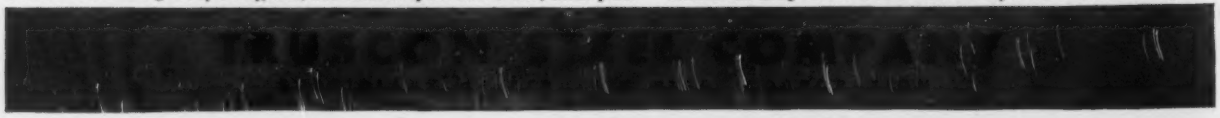
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